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Western River Steamers

Western river boats of the extreme shallow-draft type, many of which are described in this issue, occupy a unique place in the art of shipbuilding. They are designed to meet the exceptional conditions of navigation on the Western rivers of the United States, where the stages of water vary from 12 inches to 70 feet, and where low-water periods prevail from three to five months of the year. Their design is based upon the practical knowledge of experienced river navigators and practical mechanics of a generation ago, rather than upon modern theories of naval architecture and marine engineering. In their general characteristics the modern sternwheel packet and tow boats differ little from the vessels that were built in the pioneer days of the development of the West, although in details of construction of both hull and machinery improvements and refinements have been widely adopted. Notwithstanding their apparently antiquated appearance, however, these vessels are likely to retain their position of superiority for the special services for which they are built until the continued improvement of the Western rivers has established new conditions of navigation.

Sternwheel Versus Tunnel Stern Boats

Although the sternwheel towboat is peculiarly adapted for the difficult operations of flanking, backing, drifting and quick handling in handling large tows downstream in the natural currents of the large Western rivers, such as the Mississippi and Ohio, the conditions of navigation on these rivers is gradually changing, especially on the upper Ohio and its main tributaries, where the completion of locks and dams will in a few years divide the river into a system of pools providing slack water or "pool" navigation during the late spring, summer and fall months. Under these conditions the peculiar advantages of the sternwheel towboat in flanking and backing, in handling large tows in "running" water, will not be so essential, and as the tows will be smaller, being limited by the capacity of the locks, it is probable that a different type of towboat will be developed to meet these new conditions. These facts are fully recognized by river navigators, as is acknowledged in the article on Western river steamers, published elsewhere in this issue. Under these circumstances it is not unlikely that the twin-screw tunnel

stern type of towboat will be looked upon by river boat owners with more favor than has been the case hitherto, as considerable progress has already been made in the development of this type of towboat, with satisfactory results. For a shallow-draft propeller towboat the diameter of the propeller is, of course, an important consideration, and apparently the best possible solution of this problem so far advanced is the tunnel stern type of boat, in which the propeller, while not wholly immersed while the boat is at rest, may be provided with a solid stream of water to work in when the boat is in motion. In addition to this, by placing rudders aft of the propellers the steering qualities of the towboat when going ahead are exceptionally good. If the screw-propelled towboat proves successful in meeting the new conditions of navigation on improved inland waterways, it has the further advantage that there will be greater latitude for the adoption of improved and more efficient propelling machinery, a direction in which substantial economies should confidently be looked for.

Regulation of Steamship Lines

The recent investigation of shipping combinations by the Congressional committee on merchant marine and fisheries has directed public attention to the almost universal practice of steamship lines engaging in the American foreign trade to operate, both on the in-bound and out-bound voyages, under the terms of written agreements, conference arrangements or gentlemen's understandings, which have for their principal purpose the regulation of competition through either the fixing or regulation of rates, the apportionment of traffic, the pooling of earnings or meeting the competition of non-conference lines. Eighty such agreements or understandings involve practically all the regular steamship lines operating on nearly every American foreign-trade route. In the domestic trade similar agreements between steamship lines are few. Competition in rates between domestic lines, however, has been quite as effectively eliminated as in the foreign trade, either through the acquisition of steamship lines or the ownership of accessories to the lines, through agreements or understandings, or through special practices. The generally recognized advantages resulting from the agreements and conferences maintained in the foreign trade, if honestly and fairly conducted, it is believed by the investigating

committee, can be secured only by permitting the several lines in any given trade to co-operate through some form of rate and pooling arrangement under government supervision and control. Effective government control is also believed to be the only way in which the disadvantages and abuses inherent with steamship agreements and conferences as now conducted can be eliminated. A bill was, therefore, introduced at the last session of Congress providing that steamship lines engaged in the foreign trade of the United States be brought under the supervision of the Interstate Commerce Commission as regards the regulation of rates, approval of contracts and other conditions affecting the interests of the shippers. If this bill should become a law, rebating of freight rates would be made illegal, the use of "fighting ships" and deferred rebates would be prohibited and the Interstate Commerce Commission would be empowered to investigate fully complaints of unfairness as to rates and other discriminating acts on the part of the steamship lines. Suitable provisions are also incorporated in the bill for regulating the domestic lines; and as its enactment into law would undoubtedly tend to simplify the question of government aid to private lines, it should receive the support of shipping interests.

River, Lake, Bay and Sound Steamers

Shipbuilders in the United States have produced a special class of steam vessels for river, lake, bay and sound service of which they may be justly proud. These vessels range all the way from swift triple-screw, turbine-driven vessels to shallow-draft paddle-wheel steamers propelled by simple beam engines or compound inclined engines, some of them having a capacity of from 5,000 to 6,000 passengers. The main particulars of most of these vessels are well known and many of them have been described at length in previous issues of this journal. A review of the general characteristics of the hulls and machinery of these vessels which is of special interest, however, is given in a paper by Mr. Andrew Fletcher, presented at the International Engineering Congress in San Francisco.

Comparatively few of the river, lake, bay and sound steamers are built under classification rules, as the owners adhere largely to the constructional details of their previous steamers, in most cases adopting the suggestions of their naval architects and builders to suit the special demands of service. Except in cases of the large passenger boats of the Sound, Great Lakes and outside service types, single bottoms are generally used. Joggle shell plating has been extensively used rather than joggle framing, but in the opinion of the author of the paper the latter probably will be more generally adopted. Bulb angles, when readily obtainable from the rolling mills, have been largely used for frames, intercostals and deck beams. In recent years a greater amount of flanging in lieu of angle bars has been used for reverse frames, floors, intercostals, gussets and bulkheads. A system of longitudinal trussing

from floors to main deck is very often used in the larger type of river steamers and the comparatively shallow-draft steamers on the inland lakes. A deck beam on every frame is the usual practice. The guard beams of the paddle steamers are generally bracketed to the gunwale strake and secured to the lodger plate rather than extending the main deck beams from outside to outside. Guard braces are usually of the truss frame type instead of the pipe or solid round bar construction. Sponsons, as a rule, are used only on the larger type of paddle Sound steamers. In screw steamers the shell plating is formed to act as sponsons where the guards overhang. In recent practice a greater number of watertight bulkheads unpierced by doors are used. There are two exits from each watertight compartment above floors and a more extensive and reliable pumping system for watertight compartments is provided, with duplication of pumps on the main deck on the large steamers.

As has been stated, the machinery of the paddle steamers varies from the old but very reliable simple beam engine to the more modern and efficient compound and three-cylinder compound inclined and four-cylinder compound, double inclined engines. The simple beam engine has great durability, low initial cost and low maintenance cost. The paddle wheels are of the feathering type with steel floats, and the engines work in some cases at a piston speed of 650 feet per minute. The boilers employed are of the old type of flue and return tubular boilers of 55 pounds per square inch working pressure, with long grates, high fireboxes and simple forced draft, both under and over the grates. These features make a satisfactory equipment for short or special routes for lake, river and harbor excursion boats.

Double poppet valves are used on simple beam engines, generally with fixed Stevens cut-off and, in some cases, with adjustable Sickle's dash-pot cut-off. Double trip shafts for raising the main steam and exhaust valves are used on the larger engines, one trip shaft being for use by hand and the other for operation by steam, as may be desired, when the boat is maneuvering or approaching or leaving a pier when the main valve eccentric gear is disconnected. The main valves of the inclined engines of the paddle steamers are unusually of the double-beat poppet type, although, in some cases, the box balanced slide valve is used on the high-pressure and double-ported side valves on the low-pressure cylinders. Stephenson link gear is generally used, although the Walschaert gear has given excellent results. Piston valves have also been extensively used.

The main air pumps are generally worked by the main engines. The condensers, main auxiliaries, feed-water heaters, filters, etc., are of customary types. While jet condensers have in the past been mostly used on the Great Lakes in combination with water purifiers, in recent years surface condensers have been largely adopted.

With inclined engines, boilers of the Scotch type with working pressures of from 130 to 180 pounds per square

inch are generally used, usually with Howden's system of forced draft. While Scotch boilers are generally used for the screw steamers, watertube boilers have been fitted to a number of vessels with excellent results. Superheated steam has not as yet been extensively used by vessels of this type.

Vessels of the types referred to in this paper are unsurpassed in any other part of the world in point of size, appointments, safety and efficiency. They represent a distinct achievement for American shipbuilders, and will long serve as an example for the kind of service for which they were designed.

Decline in Traffic on Inland Waterways

In spite of the immense sums of money that have been expended for the improvement of inland waterways in the United States (probably in the neighborhood of three-quarters of a billion dollars), the total river traffic of the country has steadily decreased, so that at the present time few rivers are used to anything approaching their full capacity. As a matter of fact, the only inland waterways that have not steadily lost ground in recent years are the Ohio River and the Great Lakes. The favorable showing on the Great Lakes is due to the transportation of heavy bulk freight, such as ore, coal and grain; while on the Ohio River an enormous coal traffic is kept up chiefly because barges can be loaded directly from the mines on the upper reaches of that river and its tributaries. On the Mississippi River, which, in pioneer days, was the main connecting link between the communities in the Mississippi Valley and the outer world, the total river tonnage at St. Louis has diminished from 1,332,885 tons in 1886 to 365,920 tons in 1908. The entire commerce of the Mississippi River system, including all tributaries except the Ohio, in 1889 amounted to 12,492,535 tons, while in 1906 it had dwindled to 4,304,288 tons—this in spite of the fact that an 8-foot channel is now maintained from St. Louis to New Orleans, and within a few years a permanent 6-foot channel will be available from St. Louis to Minneapolis. The same, or an even greater, decrease is also found on the canals in the United States. Out of a total of nearly 5,000 miles of canals, more than half have been abandoned.

Generally speaking, the decline of navigation lines on inland waterways is due largely to the natural expansion and legitimate competition of the railroads. The advantages which railroads possess over inland waterways for traffic are clearly set forth by Mr. Walter S. Fisher in a recent issue of the *Journal of Political Economy*. The railroads can provide shorter and more direct routes; they are practically unhampered by climatic conditions; they can provide practically unlimited extensions for the collection and delivery of freight remote from their main lines; a thousand conveniences and economies are possible by using the car unit of the railroads, with which transshipment is cheaper and quicker than transshipment from

boat to boat. Another decided advantage of the railroads is their superior administration and organization, and the fact that they practically insure their freight.

Granting these advantages to the railroads, nevertheless there is another side of the question to be considered. Investigations by the Congressional committee on merchant marine and fisheries have produced ample evidence to show that the railroads have successfully opposed the maintenance and development of river and canal traffic by a variety of effective methods, mainly by acquiring competitive water lines and canals, by obtaining control of the terminal facilities, by the use of rebates or by the undercutting of rates. Since the railroads reach all sections of the interior, while the inland navigation lines are restricted to their water course, they can easily control so large a proportion of the total freight as to leave the water lines insufficient freight to maintain proper terminals and efficient service. So large a portion of railway traffic is free from water competition that railways can readily afford to reduce rates on those portions affected by such competition, so as to destroy the profits of the water lines without appreciably affecting the profits of the rail systems, which recoup these reductions by higher rates elsewhere. The Mississippi River, for instance, is paralleled on both sides by railroads. River steamers can still underbid the railroads to some extent on local traffic, but they are at a disadvantage in loading or terminal expenses and in insurance risks, as well as on account of the hazards of navigation due to the varying stages of the river. On the Mississippi, packet line services have for the most part disappeared, owing to the railroad competition, and the same handicap is also found on other large rivers in the country. Most of the canals of the country have also passed into the hands of competing railroads. At present about 90 percent of the mileage of the private canals still in operation is under railroad control.

The decline of river traffic can be laid, of course, to other causes besides the discrimination in railroad rates, although the opposition by the railroads is by far the most important. One of the greatest handicaps to inland navigation is the absence of terminals. On an experimental trip of a thousand-ton, self-propelled steel barge from New Orleans to St. Louis the total cost of loading and unloading the barge on the trip was 63 percent of the gross receipts for the freight carried. No greater obstacle could be placed in the path of transportation than to ignore entirely the question of terminals. In addition to this, the water lines should be linked up with the railroads, so that one will supplement the other without destructive rate wars. Better banking and insurance facilities would also go far towards improving conditions in the improvement of inland navigation, all of which is to be looked for when the general public begins to realize that the navigation of inland waterways is an important economic factor in the transportation systems of the country.

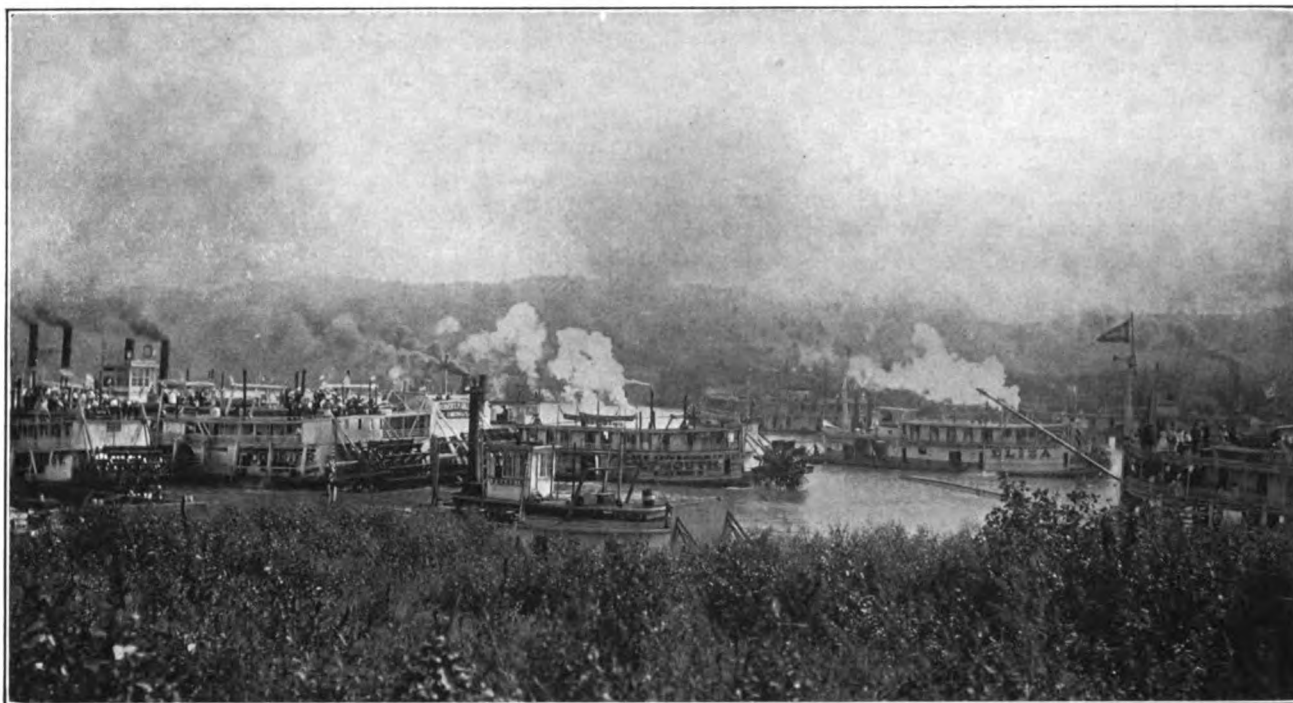


Fig. 1.—River Steamers Assembled at Gallipolis, Ohio, on September 6, to Celebrate Completion of Lock and Dam No. 26 in the Ohio River

Western River Steamers and Barges

Peculiar Requirements for Downstream Towing in "Running" Water—Construction of Towboats and Barges

BY CAPTAIN E. A. BURNSIDE *

In an article published in the November, 1913, issue of *INTERNATIONAL MARINE ENGINEERING*, attention was called to the prevailing types of stern wheel towboats and the smaller packet boats used on the Western and Southern rivers of the United States, and also to the satisfactory operation and use of this class of boats. Such vessels have been designed and built to meet the exceptional conditions found on the Western rivers of the United States, where the stages of water vary from 12 inches to 70 feet, and where the low water periods range from three to five months of the year. An important requirement for these boats has been low first cost, and for this reason they have hitherto generally been constructed of wood. In the article referred to the statement was made that for downstream towing in the natural current, or "running water" as it is termed, of such rivers as the Ohio and Mississippi and their navigable tributaries, where the widely varying and oftentimes difficult operations of flanking, backing, drifting and quick handling in backing are required, no type of steamer surpasses the prevailing types of the stern wheel towboats.

These stern wheel towboats are built along the same general lines and after the same models that were used forty years ago. Three or four rudders are placed forward of the paddle wheels, which in backing give tremendous twisting power, the immersed part of the three rudders having an area of from 115 to 150 square feet and sometimes up to 175 square feet. These boats are the only types that can successfully navigate these rivers and

maneuver and handle the large tows in running water.

Of course there have been improvements consisting of refinements in the construction of hulls, engines and boilers, and in the use of new labor-saving machinery. Tandem compound condensing and non-condensing engines have been used in place of the simple high-pressure engines. Refrigerating plants and steam steering apparatus have been introduced. Sanitary drinking fountains, providing cold water for the crews, filters for the drinking water, electric lights and searchlights have been provided. Improved furnaces have been made and several types of both watertube and firetube boilers have been designed, but, nevertheless, the same general lines of design that were in vogue forty years ago still prevail to a great extent, and many of the older boats built thirty-five years ago are doing splendid service to-day at a comparatively low operating cost, using the old style high-pressure engine.

For packet service also these stern wheel boats leave little room for improvements in their handling qualities in getting in and out of difficult and shallow landings. A friend of the writer, recently manager of a steamboat company operating a line of about fifty steamers on the Amazon River in Brazil, has had an opportunity to observe the performance of this class of steamers, principally stern-wheelers built in various countries—some in Holland, some in France, some in England and some in the United States. The stern-wheelers which this company had in service were the most satisfactory and most efficient of all the vessels they owned, and the manager of the company is responsible for the statement that the American-built boats were superior to any of the others

* Member Society Naval Architects and Marine Engineers and member National Board Steam Navigation.

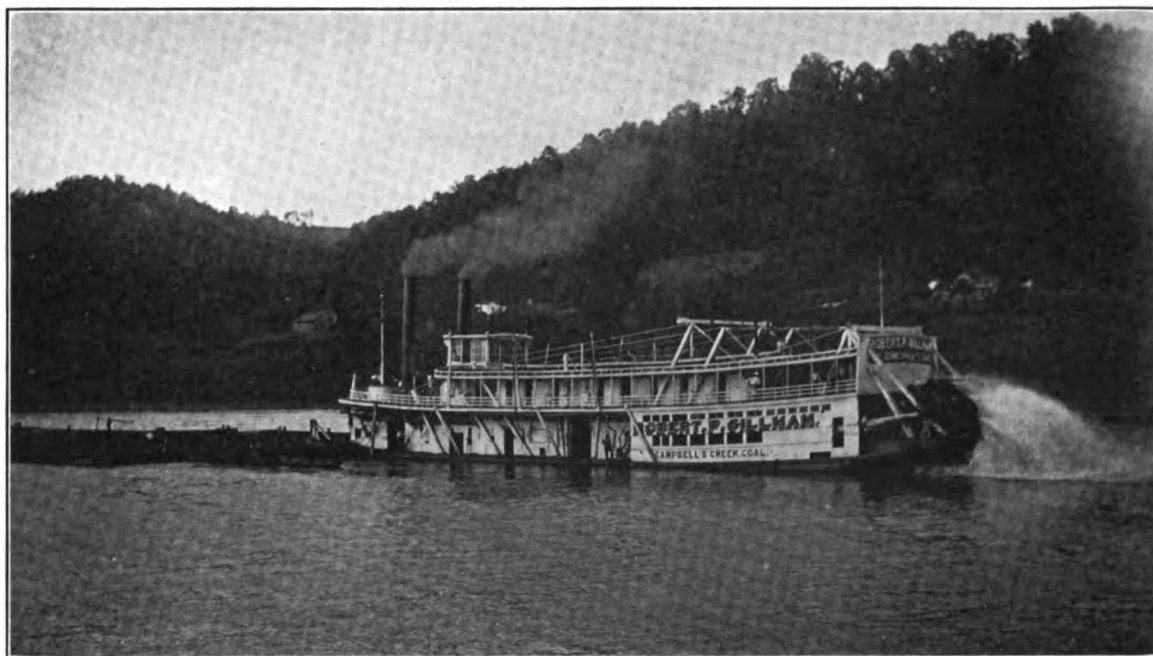


Fig. 2.—"Pool" Type Towboat *Robert P. Gillham* under way with tow of barges

in points of general maneuvering and handling, balance, proportion and in power when the boats were compared ton for ton. This does not mean that the American boats were better built or stancher, but there is a certain quality in their design and the disposition of the boilers and machinery that give them a decided advantage over the other boats.

These boats were designed and built by men who have built many river boats for service on the American rivers and by men who were practical river navigators themselves and knew exactly what was needed to make the boats thoroughly suited for the work. Besides the personal experience which these builders had obtained from observation of the construction of many other boats during

their generation, many of the builders came from families whose fathers and grandfathers were engaged in the construction of the same general type of stern and side wheel river boats, and invariably information and traditions were handed down from generation to generation in these firms, culminating in unrivaled excellence in the design and construction of such boats.

Although the Amazon boats referred to above were built for passenger and freight traffic, and this article applies particularly to the stern wheel towboats, nevertheless the same type of stern wheel boats are built for service on rivers in all parts of the world with certain changes in design to suit the conditions obtaining on the various rivers. One firm of American boat builders has stern

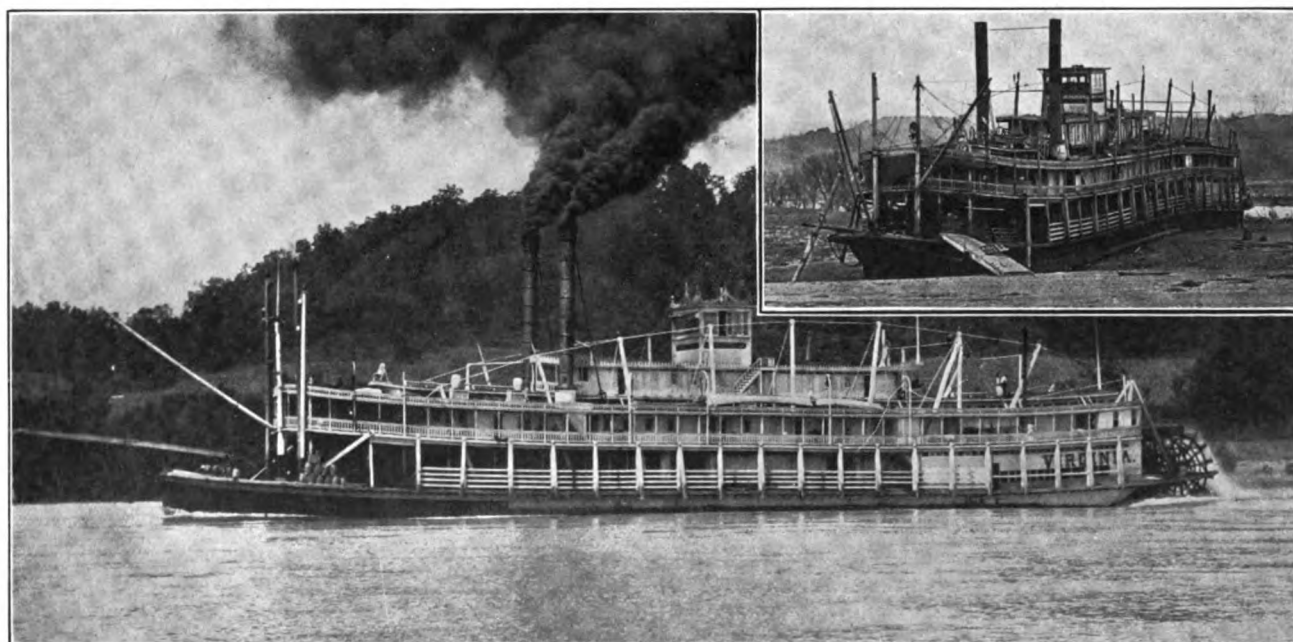
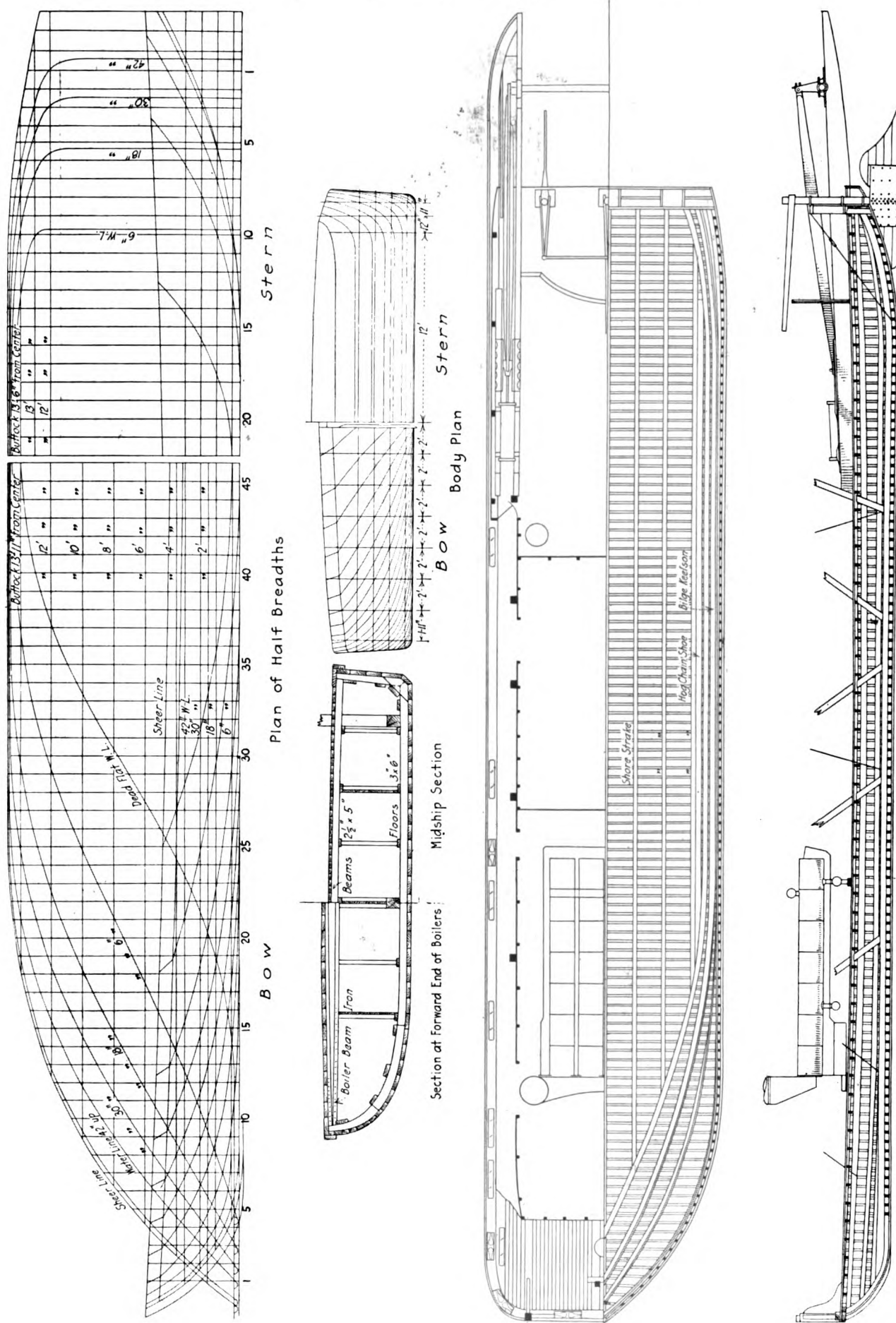


Fig. 3.—Large Passenger and Freight Steamer *Virginia*. Insert Shows the *Virginia* Stranded in a Corn Field, 200 Feet from the River, Illustrating Hazards of Navigation on Western Rivers. The Vessel Was Later Floated Again and Resumed Her Service on the River



Construction Plan
Fig. 4.—Lines and Construction Plans of Wooden Sternwheel Towboat

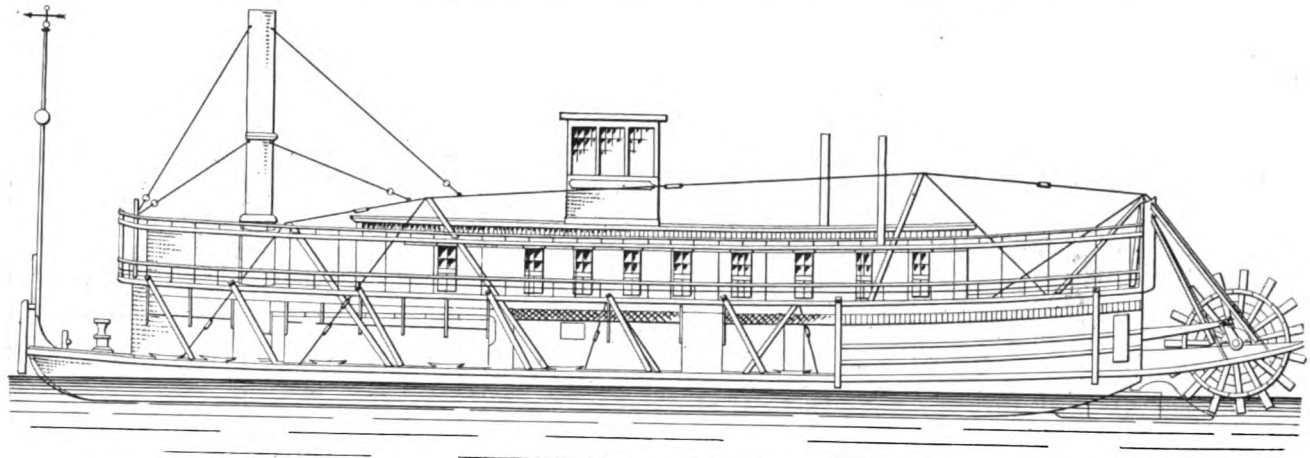


Fig. 5.—Outboard Profile of "Full-Roofed" Sternwheel Towboat

wheel boats of their construction on most of the navigable rivers of the world except possibly the rivers of Central Europe and England. The same can be said of the American-built stern wheel towboat. In the writer's opinion nothing better can be designed for towing on any rivers where shallow draft hulls are used and where the conditions of service are similar to those on the American

channel more easily, note the changes in sand reefs more quickly, and at the same time have a better view of his tow and the shores of the river, etc. Probably the most efficient and powerful of the smaller class of full-roof towboats is the stern wheel, steel hull steamer *Slack Barrett*, completed in 1914 and fully illustrated and described in the November, 1914, issue of INTERNATIONAL MARINE

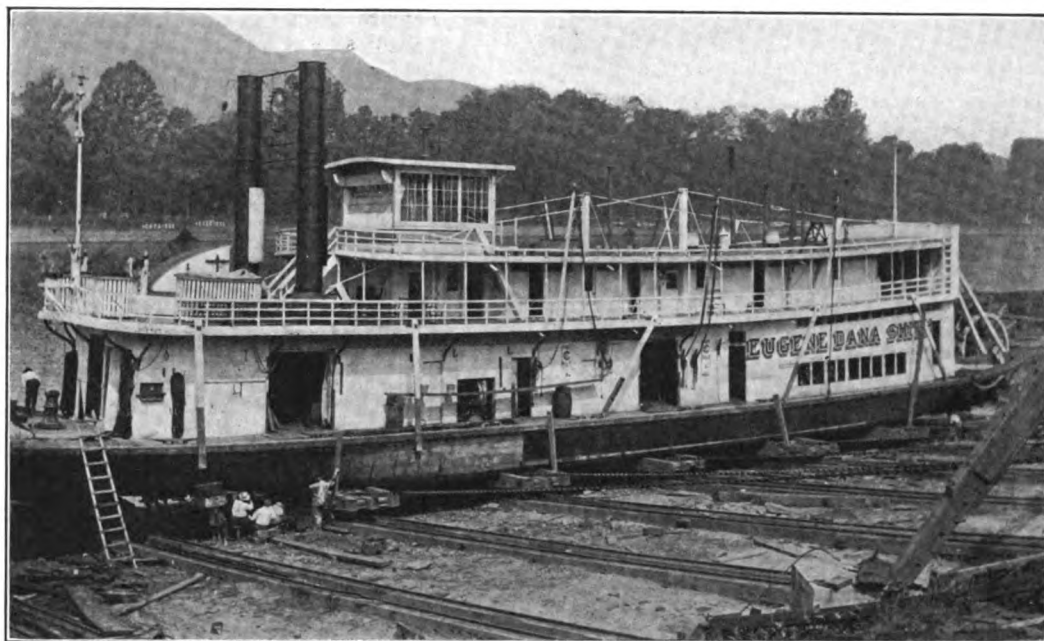


Fig. 6.—"Pool" Boat Type of Sternwheeler on Ways for Repairs

Western rivers—that is, for handling large tows downstream in running water.

There are two general types of stern wheel towboats in use on the Western rivers. This general classification applies mainly, however, to their structural appearance. The smaller type is made with the pilot house down on the boiler deck in front of the cabin, and is known as the "pool boat" type. This construction is adopted so that the boat can go under low bridges as contrasted with the regular type of towboat with full roof, with the pilot house on top of the hurricane deck, from which the pilot can have a clear view both forward and aft. The higher elevation of the pilot house on the regular towboats is also an added advantage to the pilot in that he can pick out the

ENGINEERING. This steamer has a scow bow in place of the usual model bow, and was designed by her owner, Captain O. F. Barrett, for special work. This boat more than fulfills all the expectations of the owner and builders.

Many people are under the impression that the ordinary paddle wheel used on Western river towboats and stern-wheelers generally revolves or turns in a very sluggish manner. Fig. 2 shows a typical stern wheel towboat going down the river with her wheel turning at about 22 revolutions per minute with a tow ahead of 16 barges of 550 tons each. The wheel on this boat is 22 feet long, 19 feet diameter, with buckets 31 inches wide. The wheel shaft is a Bethlehem nickel steel hollow forging with cast steel cranks, flanges, etc. The weight of the wheel shaft

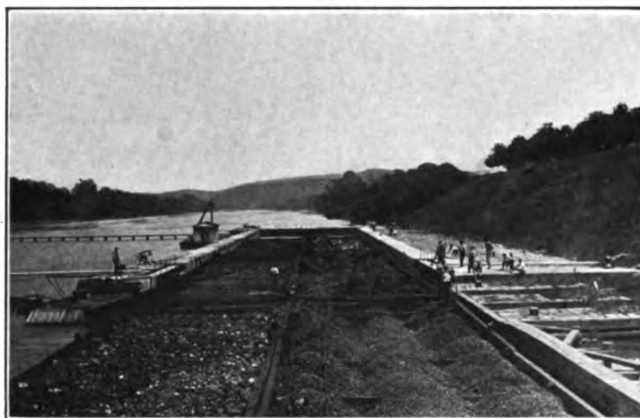


Fig. 7.—Coal Barges in Lock Chamber at River Dam

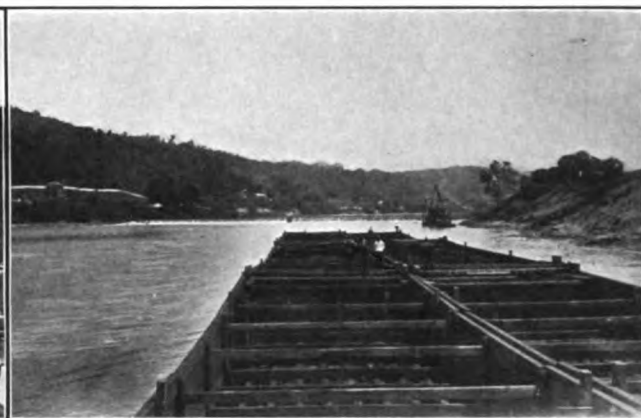


Fig. 8.—Empty Barges Approaching Lock and Dam

with fittings is 16,000 pounds, while the weight of the wheel complete is 36,000 pounds. The center of the wheel shaft bearings is 13 feet from the hull.

Until a few years ago the low cost of wooden boat construction was the principal reason for building nearly all Western river tow and packet boats of wood, but at the present time the increasing cost and scarcity of good boat timber are causing a change, and probably one-third, or at least 25 percent, of the recent boats are built of steel. Formerly but few boat-building plants along the rivers could turn out steel or iron boats, and there were few men who could design and build anything except a wooden boat. Now, however, there are a number of large ship-building plants located on the Western rivers where vessels of any ordinary size can be built of steel. Prominent among these firms are the James Rees & Sons Company, Pittsburgh; the American Bridge Company, Pittsburgh; E. J. Howard, Jeffersonville, Ind.; the Charles Ward Engineering Works, Charleston, W. Va.; Charles Barnes Company, Cincinnati, Ohio; the Dubuque Iron Company, Dubuque, Iowa, and others. Now that the river men are realizing the increased value and the greater length of service with greater safety of steel boats when built with compartments, the former high first cost is discounted and the greater life of the steel boat makes the cost in the end much cheaper.

Another great advantage of the steel boat is that it never becomes waterlogged—that is, it does not get heavier with age, as is the case with wooden hulls, and the draft of the steel boat when first built is her draft ten

years later, whereas the draft of a wooden boat in ten years would increase approximately 15 to 20 percent. Moreover, the steel boat will keep its shape and sheer with little or no hog-chaining and will stand more severe shocks and collisions with rocks and snags with much less damage than is the case with the wooden boat. These advantages all make the steel boat far cheaper than a wooden boat, and the cheaper first cost of the wooden boat is eliminated in two or three years, the steel boat then showing its value and stability.

Wooden towboats equipped with boilers and engines ready for steam, but not including cabin and deck equipment, lines, syphons, syphon rigging, chains, wires, etc., cost at the present time about \$200 (41/13/4) to \$250 (52/1/8) per net registered ton. Wooden passenger and freight boats cost from \$150 (31/5/0) to \$225 (46/17/6) per net ton. The greater cost of the towboat construction is accounted for in the heavy timbers used and the greater strength required, as well as the much heavier power plants which are necessary on the towboats. Some very light wooden packet boats have been built as low as \$125 (26/0/10) per net ton.

Steel hull construction will not cost much more than wood when consideration is given to the greater safety and strength of the steel hull. As previously stated, the higher first cost is eliminated in a few years. The life of a wooden boat rebuilt once or twice is about twenty years. On the other hand, the steel hull with proper care and painting

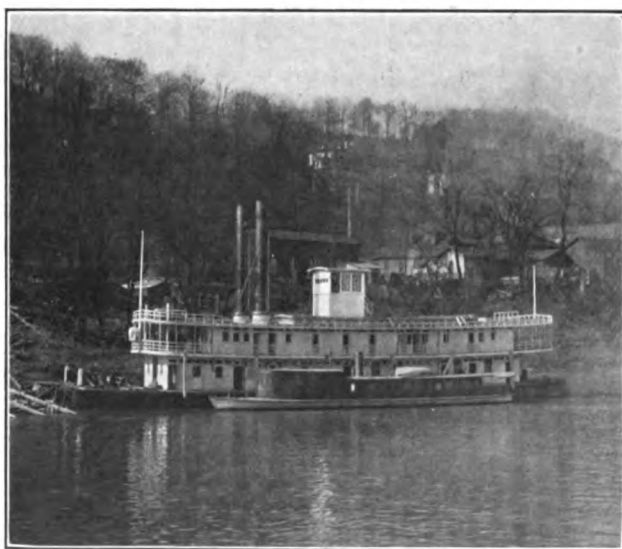
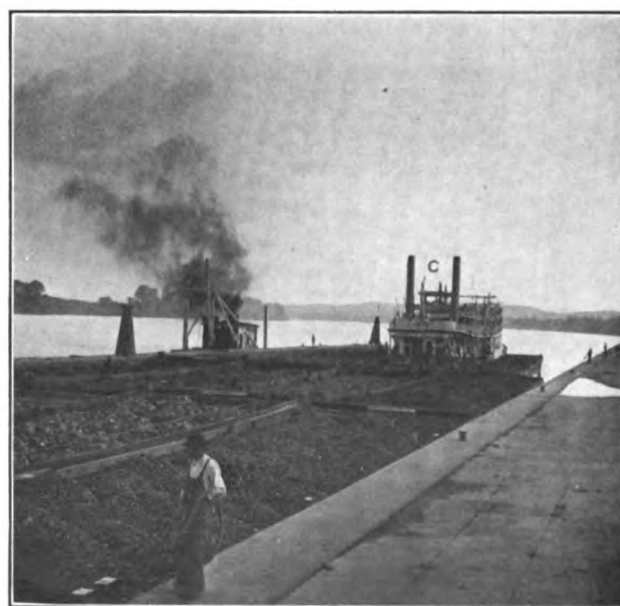
Fig. 9.—U. S. S. *Inspector*, Twin-Screw Tunnel Towboat Built by the Ward Engineering Works, Charleston, W. Va.

Fig. 10.—A River Tow in Lock Chamber

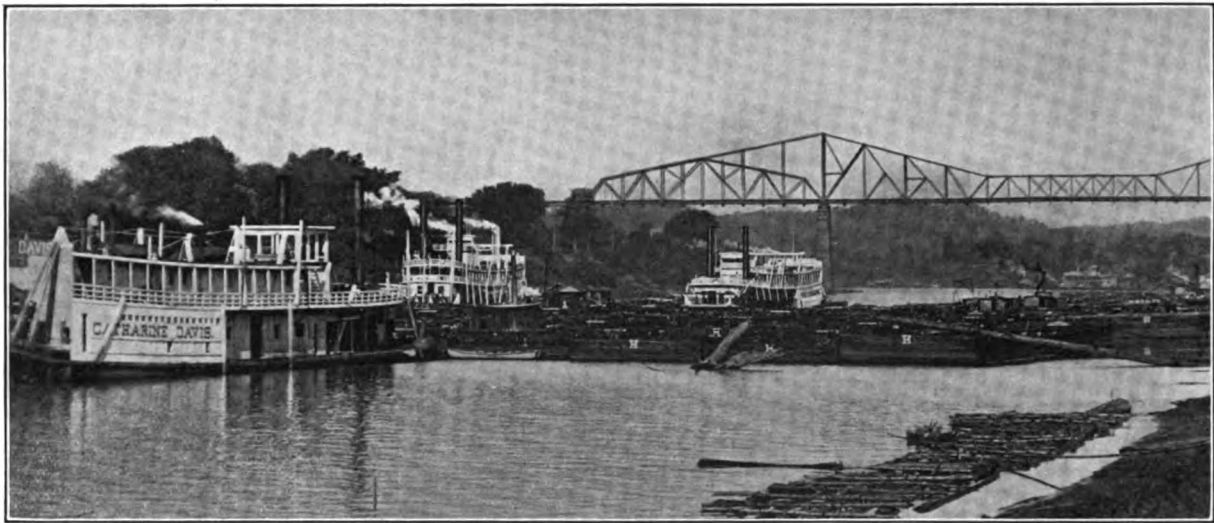


Fig. 11.—Blockade of 120 Barges and 3 Towboats in Kanawha River at Point Pleasant, W. Va.



Fig. 12.—Towboat Landing at Mouth of Kanawha River, Where Large Tows Are Made Up to Go Down the Ohio

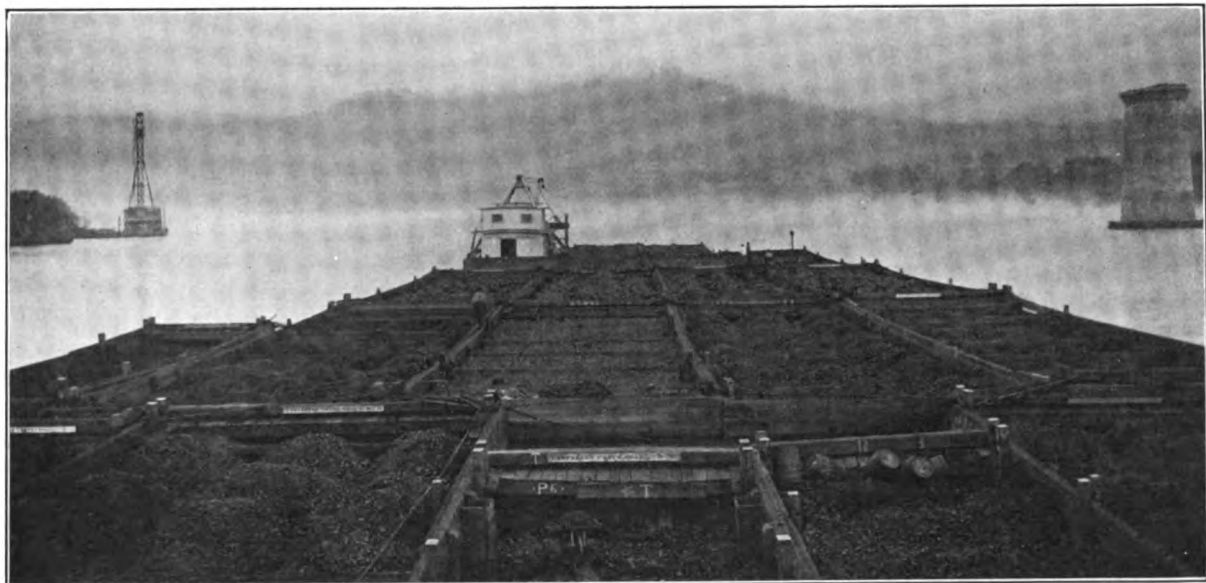


Fig. 13.—Loaded Tow Bound Downstream. View from Pilot House of Towboat

and with no disastrous accidents will last forty years or more. The cost of the best class of steel towboat construction, equipped with tandem compound condensing engines, cylindrical two-flue boilers, electric lights, steam steering gear, wooden cabin and upper works, but without cabin and deck outfit, will run from \$300 (62/10/0) to \$350 (72/18/4), while steel passenger boat construction, with tandem compound engines, non-condensing, with wood cabins and upper works, electric lights, steam steering gear and small refrigerating plant, but with no outfit, will run from \$250 (52/1/8) to \$300 (62/10/0) per net ton. With steel towboats with improved tandem compound condensing engines, horizontal two-flued boilers, steam steering gear, electric lights, filters, refrigerating plant, etc., the machinery cost is about one-half the entire cost of the vessel, unless the boat is of more than the ordinary size of hull. In the ordinary wooden towboats the machinery cost, including boilers, steering gear, electric lights, etc., will run about two-fifths of the cost of the vessel. The difference in cost between the wood and steel hull construction will run about 33 to 60 percent more for the steel, owing to the general construction problems, weights of material, etc. The tonnage given above is the United States Custom House tonnage and not the deadweight or displacement tonnage of the boats.

EFFECT OF CHANGING CONDITIONS ON NAVIGATION

While in the opinion of the writer the regular stern wheel type of towboats will never be surpassed for downstream handling of large tows in running water, or in a current on shoal water, where flanking and other operations are required, nevertheless conditions are changing at the present time with the complete canalization of the upper Ohio from Pittsburgh to Louisville. In a few years the whole of the upper Ohio and all its main tributaries will be improved with locks and dams and we will then have slack water navigation in the late spring, summer and fall months. Under these conditions, it is probable that boat owners and coal shippers will find another type of towboat especially designed for use in "pool" waters—that is, rivers where the water is dammed and use is made of the locks. When this is brought about, there will be a good stage of water in the rivers between the dams with little or no current, so that the peculiar advantages of the stern wheel type of towboats for running water navigation will not be required. Flanking and other qualities peculiar to the stern wheel boats will not be essential in slack water, nor will the tows be as large as at present, as they will be limited to the capacity of the locks. On the other hand, more ahead steerage power will be required, and this cannot be supplied by the stern wheel boat without frequent stops to back and twist, and with little or no current flanking will not be required.

The probable partial successor to the stern wheel boat for slack water tow navigation will undoubtedly be the twin screw tunnel type of towboat, and during the next few years it is very probable that improvements will be made in the design of both hulls and machinery for the tunnel type of boats, especially fitting them for this class of towing and other special work. They will be much cheaper in operating costs, both in the wages of the crew and consumption of fuel. Greater ahead steerage power will be supplied by these twin screw tunnel towboats with part of their rudders' aft of the wheels to get the full force of the stream of water from the wheels. The builders of this class of boats are making decided and rapid progress in their designs and important results can undoubtedly be looked for in the future.

The engines to be used on the twin screw tunnel towboats will be of the vertical or other type of compound

and triple expansion engines of high speed with specially designed boilers with the horsepower running from 700 to 900. In spite of this, however, let it be said that the old type of stern wheel tow and packet boat will be used for many, many years, and those of us of the old school of towboat men cannot see how any vessel can be designed to surpass the old stern wheel towboat for handling large tows down stream in running water. The tows of the larger towboats vary from eighteen to thirty barges, and as these boats navigate in heavy ice and drift, the big wheels of these towboats break up the smaller drift logs and also break up large ice floes so they can back through them with remarkable effectiveness. This is done usually with but little damage to the wheels; and even if the wheels are broken, material is carried on the boats to make immediate and speedy repairs. This is frequently done while the boat is floating or drifting with the current.

TROUBLES WITH RIVER BOAT BOILERS

The question of boilers is a serious one for Western river boat owners. The old style horizontal flue boiler generally used, while remarkably effective as a steamer and cheap in first cost, is by no means the ideal boiler, nor has a satisfactory boiler as yet been produced for this service that will be reasonable in first cost and effective under all the various severe conditions which prevail. There are, however, two or three types of watertube boilers that are far in advance and much more effective than the older types of watertube boilers, and it is very probable that the builders, constantly gaining by experience, will devise a watertube boiler that will successfully meet the conditions imposed on river boilers. Some of these boilers, notably the Ward and Kidney, have shown some remarkable performances and are in constant use, but so far the typical Western river man sticks to his old horizontal flue boiler.

The greatest trouble with the externally fired river boat boiler, especially those used in the upper Ohio, where the water is especially bad and strongly acid, is the fire cracking of the edges of the overlapping shell plates and the corrosion of the plates by the acids and other deteriorating substances in the waters during the low water season. The boiler plate maker who can produce boiler plates of such qualities as will greatly reduce the fire cracking and corrosion will have gained the gratitude as well as the business of all river boat owners. One of the master mechanics in a big company owning a number of towboats had numerous experiments made at one of the big plate mills, using a copper alloy in the manufacture of the plates with such satisfactory results that finally he has given the mill a large order for plates of this material.

On account of the height of the elevation at which the river boat boilers must be placed above the deck, no satisfactory mechanical stoker fully adapted for use on river steamers has as yet been designed. The varying and exacting conditions under which river boilers are used apparently will make it difficult to design such a stoker that will do its work in a satisfactory manner.

The wooden coal barges generally used for transporting coal and other heavy bulk material on the Ohio and Mississippi and their tributaries, principally the Monongahela and Kanawha, were formerly constructed of white pine from the Allegheny River pine forests, but owing to the scarcity of good, long-length pine and its increasing cost, these barges are now for the most part built of Oregon and Washington fir brought by rail to the builders' yards from the Pacific coast, and at a remarkably low cost, too. The firm with which the writer is connected is building these coal barges of an approximate carrying capacity of 550 tons of this Oregon and Washington fir at about the same



Fig. 14.—Hull Nearly Completed

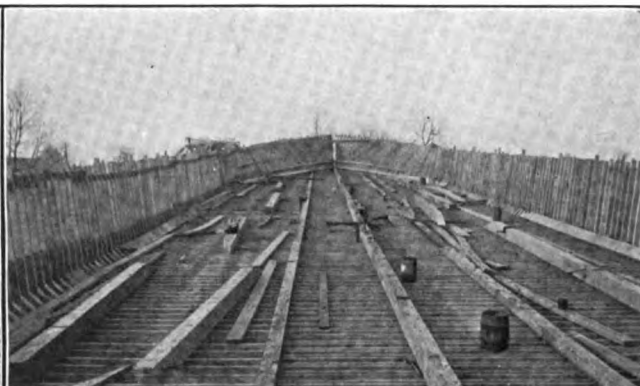


Fig. 15.—Framing of Hull

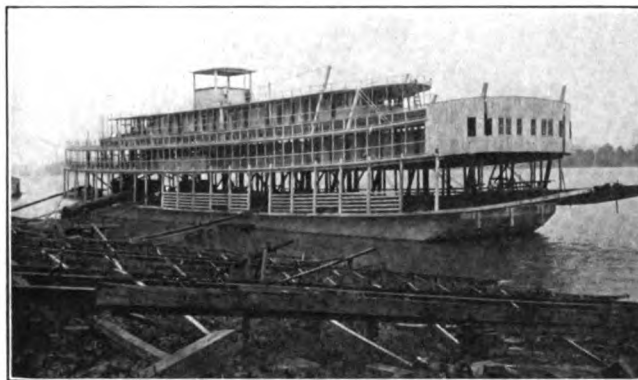


Fig. 16.—Hull with Superstructure Just After Launching



Fig. 17.—Main Deck

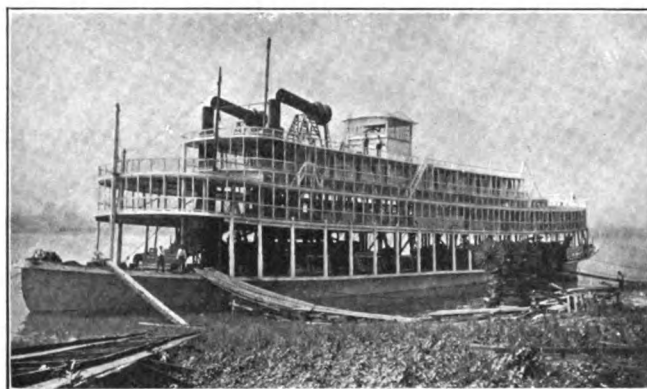
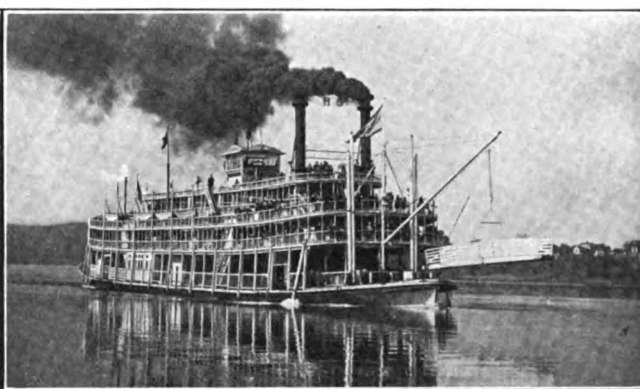


Fig. 18.—Putting the Machinery on Board

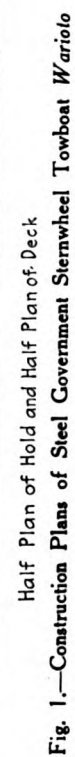
Fig. 19.—The *Homer Smith* Completed

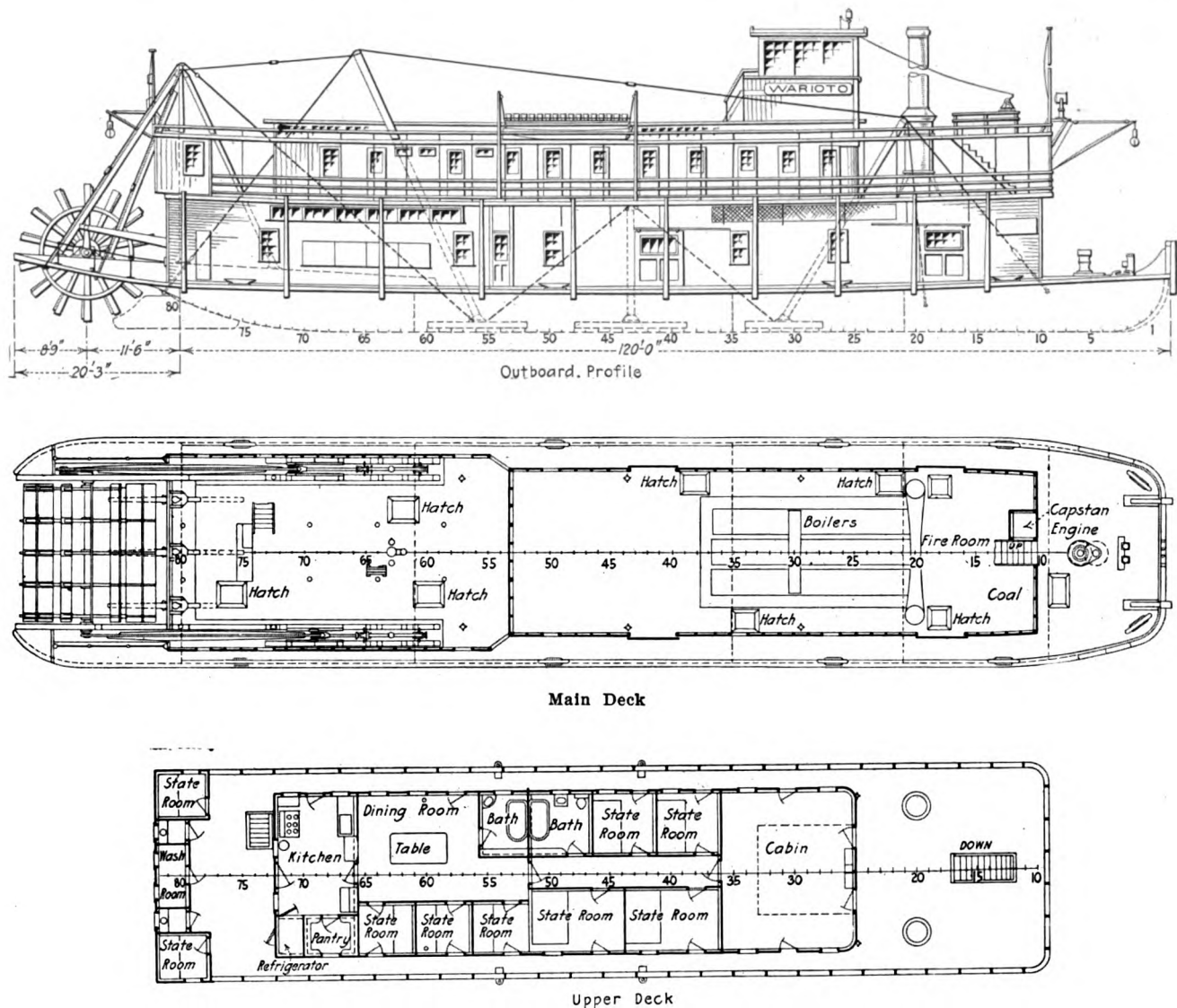
Views Showing Construction of Magnificent River Excursion Steamer, Licensed to Carry 2,800 Passengers

cost as was paid for the white pine barges some ten to twenty years ago. A 550-ton barge costs approximately \$20 (4/3/4) per net ton empty displacement, although they can be built with a little lighter timbers and less iron and calking for from \$17.50 (3/12/11) to \$18 (3/15/0) per net displacement ton. Many of the 750-ton barges are now being built of fir with the bottom gunwales of full length 125 feet in one piece at a cost of approximately \$19 (3/19/2) to \$20 (4/3/4) per net displacement ton empty. The 550-ton barges are 135 feet long, 26 feet wide, 8 feet deep and displace when light about 100 tons. The 750-ton barges are the same size overall but 9 feet deep and displace about 110 tons. In a wood barge, when the material is at hand, about six days are required to construct and

launch one of these barges, although they have been built and launched in less than five days. In the 550-ton barges there are about 43,000 feet of timber, board measure, about 350 pounds of oakum, 150 pounds of cotton and several tons of spikes, bolts and bands. The average life of these barges is from twelve to fourteen years.

Steel barges will later come into more general use. The cost of steel coal barges of the same size as the wooden ones described above runs from \$45 (9/7/6) to \$55 (11/9/2) per net displacement ton. Steel freight barges with cargo house on the deck cost from \$65 (13/10/10) to \$75 (15/12/6) per net displacement ton and carry from 1,000 to 1,200 tons of freight. With the exception of the freight barges, these steel barges are all



Fig. 2.—Profile and Deck Plans of the *Warioto*

of the open type, with no decks and with no compartments except at each end.

One of the largest and finest passenger and excursion steamers yet built on the Western rivers is the *Homer Smith*, illustrated in Figs. 14-19. She is owned by the Security Steamboat Company of Point Pleasant, W. Va., and is 272 feet extreme length over the wheel, 50 feet beam over guards, 7 feet depth of hold, about 760 tonnage, 1,100 horsepower, and is capable of speed upstream in the Ohio of 13 miles per hour. Her carrying capacity is 2,800 passengers. She is built of white oak and is propelled by two sets of tandem compound, non-condensing engines 16 and 28 inches diameter by 96 inches stroke, with variable cutoff poppet valves, steam ram and inside cam gear, all of Marietta make. The wheel shaft is of forged iron of hexagon shape, 12 inches diameter at the center, 11½ inches diameter at the journals and 32 feet long. Steam is supplied at 221 pounds gage pressure by five horizontal two-flue boilers 40 inches inside diameter and 30 feet long. The boat is equipped to carry passengers on long trips and is provided with removable as well as stationary state-rooms. A large refrigerating plant, cold storage room and duplicate electric lighting plants are installed. The cost of the boat completely equipped was \$115,000 (£23,600).

Government Towboat *Warioto*

The Dubuque Boat & Boiler Works have recently completed the two stern wheel towboats *Warioto* and *Comanche* for the U. S. Engineers. The *Warioto* is for the Nashville, Tenn., office, and is working on the Cumberland River. The *Comanche* is for the Chicago office and is to be used on the Illinois River Improvement.

Both boats are of the following dimensions:

Length between perpendiculars.....	120 feet
Length over fantails.....	141 feet
Beam, molded.....	27 feet
Depth at side.....	5 feet
Crown of deck.....	6 inches
Draft with 30 tons coal aboard.....	3 feet 8 inches
Displacement at 38½ inches waterline.....	246 short tons
Block coefficient.....	0.78

The hull is of steel and is divided into nine watertight compartments by one centerline watertight bulkhead and four transverse watertight bulkheads. There are two longitudinal trusses 6 feet 6 inches each side of the centerline, and under each cylinder beam there are fitted trusses as shown on plans.

The hull is chained by means of a system of columns and rods. The main columns are 6-inch channels latticed set-

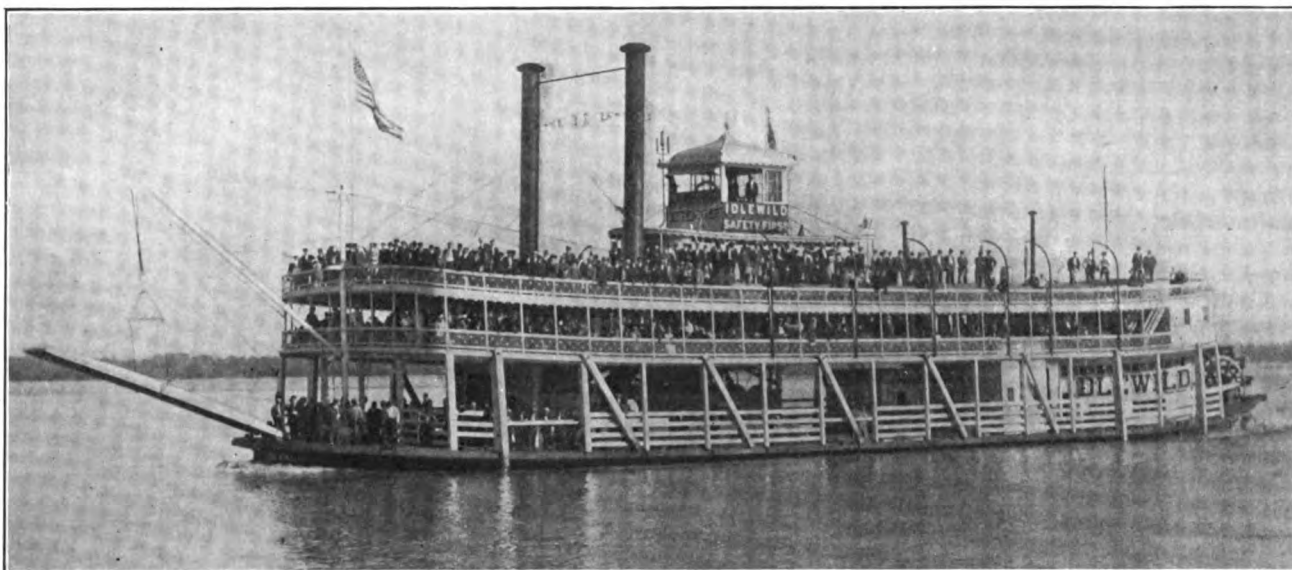


Fig. 2.—Excursion and Packet Steamer *Idlewild*, Built by Jas. Rees & Sons for the West Memphis Packet Company

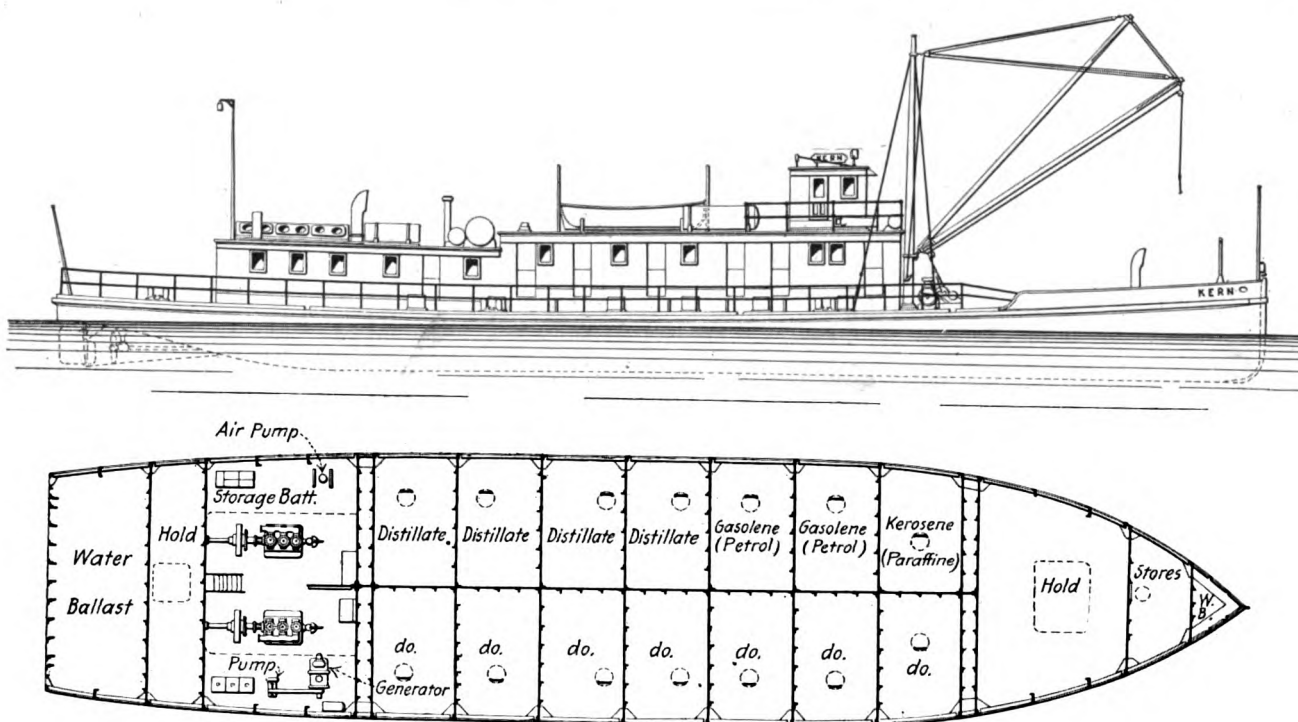
rivers for delivering refined oils from their plant at Oleum. The *Kern* is 129 feet overall, 28 feet beam and 6 feet molded depth.

The hull is built of steel throughout with the exception of the bottom, which was of iron to the turn of the bilge. This was done on account of the excessive wear on the bottom of the boat, due to the fact that she must

coal oil. Also 10 tons of cargo are carried in the forward hold, on a maximum draft of 5 feet.

Propulsion is supplied by two Meitz & Weiss reversible oil engines of 75 horsepower each. The propellers are 43 inches diameter by 40 inches pitch, running at 320 revolutions, giving the boat a speed of 8.4 knots.

The auxiliaries are composed of a 2-horsepower Fair-



Union Oil Company's Twin-Screw Motor Barge *Kern*

be grounded on sand bars in delivering her cargo, iron being considered as having better wearing qualities than steel for this scouring action.

The hull is divided into twenty-two compartments, fourteen compartments being used for refined oil, the forward and after peak tanks being used for trimming the boat when light. The cargo tanks carry 30,000 gallons distillate, 20,000 gallons gasoline (petrol) and 10,000 gallons

banks-Morse gas engine direct connected, a 3-horsepower Meitz & Weiss oil engine, driving on air pump, and a 6-horsepower Union gas engine hoist on the forward deck for hauling cargo from the forward hold.

For handling the bulk oil there is a 20-horsepower Union gas engine and four No. 1 Ramsay rotary pumps, running in pairs, connected to the engine with silent chains and operated with clutches on the engine shaft.

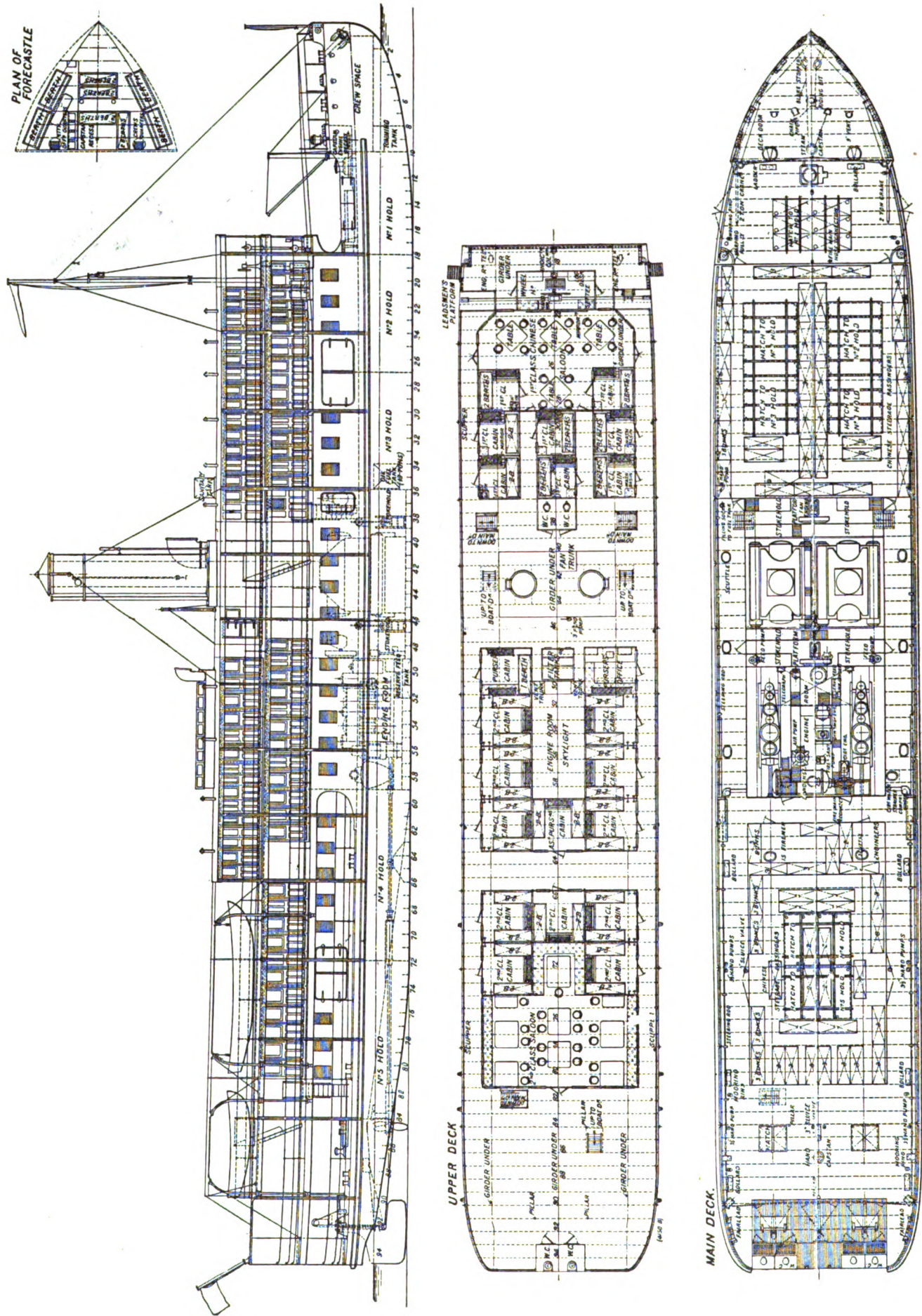


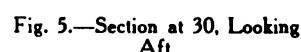
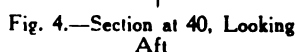
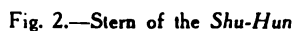
Fig. 1.—Twin-Screw, Shallow-Draft Steamer *Shu-Hun*, for the Yangtze Kiang. Constructed by Messrs. Yarrow & Co., Ltd., Scotstown, Glasgow. (Reproduced from *Engineering*)

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The *Shu-Hun* was built to the special designs of Captain S. C. Plant, one of the best-known navigators of the river, and with many years' experience on this particular part of the great inland waterway. His aim was to pro-

It was finally decided that a length of 190 feet and a beam of 30 feet was the largest size vessel which could safely navigate the rapids on a draft of 5 feet when the load of cargo was 300 tons, and the *Shu-Hun* was accordingly built to these dimensions, and with machinery of 2,000 indicated horsepower.

The general features of the design of the *Shu-Hun* are clearly shown on the drawings. The hull is divided into nineteen compartments by transverse and longitudinal bulkheads, and watertight doors are also fitted to the bunker bulkheads, as damage to the hull of vessels on this river more frequently occurs at the turn of bilge than on the bottom of the vessel. There are four decks in all—namely, main deck, upper deck, boat deck and awning deck. The accommodation for European passengers and the officers is on the boat deck. The accommodation on the upper deck is for the Chinese first and second class passengers. On the main deck there is accommodation for



170 Chinese steerage passengers, 15 firemen and three Chinese engineers.

The vessel is lighted throughout with electric light, the current being supplied by an oil-driven dynamo, so that it is not necessary to keep up steam when the vessel is moored for the night. There are five separate holds for cargo, having a total capacity of about 16,000 cubic feet, and on a draft of 5 feet the steamer has a deadweight capacity of about 300 tons.

The main propelling machinery consists of two sets of triple-expansion, surface-condensing engines, balanced on the Yarrow-Schlick-Tweedy system. Piston valves are fitted to the high-pressure, mean-pressure and low-pressure cylinders. The link motion is of the twin-bar Stevenson marine type, with adjustable bearings. All the bearings have large surfaces, so as to insure satisfactory results with these engines when running at somewhat higher revolutions than those usually adopted for this class of vessel. One condenser of the "Uniflux" type is fitted as common to both engines, and an independent Weir air pump is fitted in conjunction with it. A circulating pump by Messrs. Matthew Paul, of Dumbarton, is fitted, the engine being of the enclosed forced lubrication type. A fire and bilge pump by Messrs. Turnbull is also fitted in the engine room and arranged to pump from several compartments and the sea. At the forward end of the engine room is placed a feed filter tank.

In the closed stokeholds are fitted two Yarrow patent double-ended watertube boilers, each boiler being fitted with an independent funnel. These boilers are designed so that, if at any time an overload power is required, it can be quickly obtained by burning oil fuel in conjunction with coal. Other auxiliaries fitted in the stokehold are as follows: Two forced draft fans and engines by Messrs. Paul, of Dumbarton, the engines being of the enclosed,

forced lubrication type; two main feed pumps (one to each of the boilers) and one auxiliary feed pump, all by Messrs. Weir; and one oil fuel pump by Messrs. Mumford, of Colchester.

Fig. 2 shows the Yarrow hinged balanced flap for the propeller tunnel. The efficiency of the propellers depends upon their working in solid water, and it is therefore important that when the propeller starts revolving in the tunnel, and the air is forced out and water takes its place, there shall be no leakage back of air. The after part of the tunnel must project below the surface of the water, even when the vessel is at its lightest draft. When the vessel is loaded, and this projection is more deeply immersed, resistance is increased very considerably. Messrs. Yarrow, many years ago, arranged for the after part of this tunnel to be movable, so that it could be adjusted corresponding to the draft of the vessel. The adjustment was effected by hand, and the range was such that, while the tunnel was always sealed, the after part would only just be below the surface of the water. It was found in practice, however, that this adjustment was not always made by the ship's company. Messrs. Yarrow therefore arranged for the flap to be self-balancing, as illustrated. The forward part of the tunnel forms part of the hull in the usual way, but the after part is hinged at a point about the center of the tunnel, and the flap is balanced by means of weights attached to the end of a chain, which passes over pulleys and is secured to the end of the flap, as shown. By this means the flap automatically regulates itself. If, for instance, a quantity of cargo is put on the boat and the draft increased, the increased pressure of water on the after part of the tunnel, due to the action of the more deeply immersed propellers, tends to raise this flap, and thereby reduces its resistance. Under all conditions of load and draft the flap is always in an efficient position.

Motor Fire Float Delta II

Shallow Draft Vessel with Triple Tunnel Screws Driven by Kromhout Kerosene (Paraffin) Motors

Although a fire float is not a craft required in great numbers, the problems involved in its design are closely related to those of other shallow draft vessels, and the *Delta II*, a fire float recently constructed for the London County Council by Messrs. John Samuel White & Co., Ltd., of East Cowes, I. W., is an example of difficulties overcome by careful design. She is of the following dimensions: Length, 100 feet; breadth, extreme, 21 feet 6 inches; depth, 4 feet 1 inch, and draft, loaded, 2 feet. The main power installation consists of three sets of Kromhout kerosene (paraffin) motors, built by Messrs. Plenty & Son, of Newbury, arranged with reversing clutches to drive three screws in separate tunnels aft. Each motor develops 56 brake horsepower, and the three engines, when used together, give the vessel a speed of $10\frac{1}{2}$ knots. Each may be declutched from the tail shaft and direct coupled to a Hatfield fire pump, built by Messrs. Merryweather. The total discharge capacity is about 1,450 gallons per minute, at a pressure of 120 pounds per square inch.

One of the chief features of the installation lies in the possibility of ready and convenient starting. This is accomplished in the following manner: A small air-compressing set, consisting of a 5 horsepower Seal kerosene (paraffin) engine and Brotherhood compressor, is fitted, and this is arranged to charge some ten steel bottles to a pressure of about 150 pounds per square inch. A half

compression device is fitted to the main engines, relieving compression on the up-stroke. On the crankshaft are two cams operating timing gear for the starting air valves to each cylinder, and air from the bottles is thus admitted at the proper periods. When a start is to be made, the engines are run on compressed air until firing on gasoline (petrol) commences, after which the change from gasoline (petrol) to kerosene (paraffin) is made when sufficient heat has been generated. There is so large an air supply that a considerable amount of maneuvering can be carried out on air alone, but in addition to this the little compressing plant is capable of keeping the main engines running slowly on air, even should the bottles become exhausted. It will be seen, therefore, that the council have adopted the most certain methods of starting possible.

The main engines, a large part of whose duties consist of driving the water pumps, are liable to special demands on their flexibility. In order to get this quality in a high degree, special means have been adopted. Those of our readers who are familiar with this type of Kromhout motor will remember that ignition is effected by means of an oscillating low-tension magneto. In the present installation the timing, unlike standard practice, is variable, so that a spark can be produced at the plug points during almost any part of the stroke desired.

It is the practice in Kromhout engines always to em-

ploy a reverse gear, and as the result of experiments carried out some fourteen years ago, a type of epicyclic reversing gear was introduced whose design has proved so satisfactory that no alterations in principle have been necessary. The gear is carried in a frame which is bolted directly to the engine crankcase, assuring perfect alignment, and it may be described as fool-proof, since the gears are always in mesh and by no amount of careless handling can they become chipped or damaged.

The clutch comprises a number of steel disks placed al-

The Diesel Motor Tug Chickamauga

BY GEORGE E. NICHOLSON

A recent addition to the fleet of the Pacific Tow Boat Company, of Seattle, Wash., is the motor tug *Chickamauga*, which is the first Diesel-engined tug in America and the highest powered internal combustion engined tug on the Pacific. The boat was designed for general towing on Puget Sound and is 70 feet long, 18 feet beam and 10 feet extreme draft. She has a large wheel house raised



Motor Fire Float *Della II*, Built for the London County Council by Messrs. John Samuel White & Co., Ltd., East Cowes, I. W.

ternately with an equal number of disks in which a ring of circular plugs has been inserted. The plugs consist of a composition of sawdust and cement, compressed and hardened, and are renewable. New plugs might be required once in a period of about three years, and the operation of renewal takes some two hours. A special feature of the clutch is the absence of any kind of spring.

Owing to the slight depth of the hull it is, of course, impossible to arrange any accommodation with standing headroom under deck. A large deck house, therefore, has been erected amidships, which completely covers the engine room, and in addition encloses a roomy cabin divided by a bulkhead from a messroom, lavatory and pantry.

At the forward end the deck erection is dropped slightly, giving a rather reduced headroom to a compartment which is used as a hose room. The drop thus formed gives an excellent standing platform for the control station, which is immediately over the hose room. The main fire pump delivers through pipes to a Shand-Mason monitor on deck, which is placed amidships on the center line, and also to two distributors, each having four hose connections, on the starboard and port sides respectively. Over the cabin aft is a large searchlight.

The three propellers, of 3 feet diameter, run in three independent tunnels. The height of the tunnel above the waterline is a little less than half the propeller diameter.

Three single plate, balanced rudders are fitted aft of the propellers, one in each tunnel, and both propeller and rudder are carried sufficiently high in the tunnels to clear the ground, so that in cases of special necessity which might arise under certain conditions the boat can be beached quite safely. Inspection hatches are fitted over each of the propellers, which are, of course, fitted with a crutch, so that weeds and other *débris* may be cleared from the propellers when necessary.

The naval architects for the vessel are Messrs. Wells & Kemp of 63, Queen Victoria Street, London, E. C.

above the captain's room aft, so that from the rear windows the man at the wheel has an unobstructed view of his tow. This is a most important feature in connection with log towing.

The engine room shows the complete absence of piping and auxiliary equipment, as all of the engine piping is under the engine room floor, and the little auxiliary lighting engine, which is also hooked up to a Nleseco emer-



Fig. 1.—Tug *Chickamauga*, Equipped with Nleseco Diesel Motor

gency air compressor, is placed out of the way forward. On the starboard side are four fuel tanks, $\frac{1}{4}$ -inch steel, government inspected. She has enough fuel capacity for thirty days' running without refilling.

On deck just aft of the galley is the towing machine, which is geared to the propeller shaft; also forward is the anchor winch, so the main engine furnishes all the power requirements of the boat. There is also a pulley on the forward extension of the crankshaft which carries a belt for driving the generator, this arrangement doing

away with the necessity of using the small engine when the main engine is running.

The main propelling engine is a Nlsec Diesel four-cylinder, four-cycle, single-acting type with enclosed crank case, built by the New London Ship & Engine Company of Groton, Conn., and is rated at 240 brake horsepower at 240 revolutions per minute. The bore is 13 inches and the stroke 18 inches. The engine is reversed by means of a heavy duty reverse gear and clutch. The cylinders are each a separate casting.

The valve arrangement is a distinct feature of the Nlsec engine, the inlet and exhaust valves being hori-

located between the housing and flywheel and driven from the main shaft. This plunger pump is furnished in duplicate, and as only one is needed the extra pump provides a standby for emergency.

There is a single-acting, two-stage air compressor forward which is driven by the main crankshaft. The air obtained from the compressor is used for spraying the fuel into the cylinders and for starting the engine, the air for both purposes being stored in flasks and placed out of the way in the bilges. Air for the original starting and fuel injection is obtained from the emergency compressor driven by the auxiliary engine. After the installation of

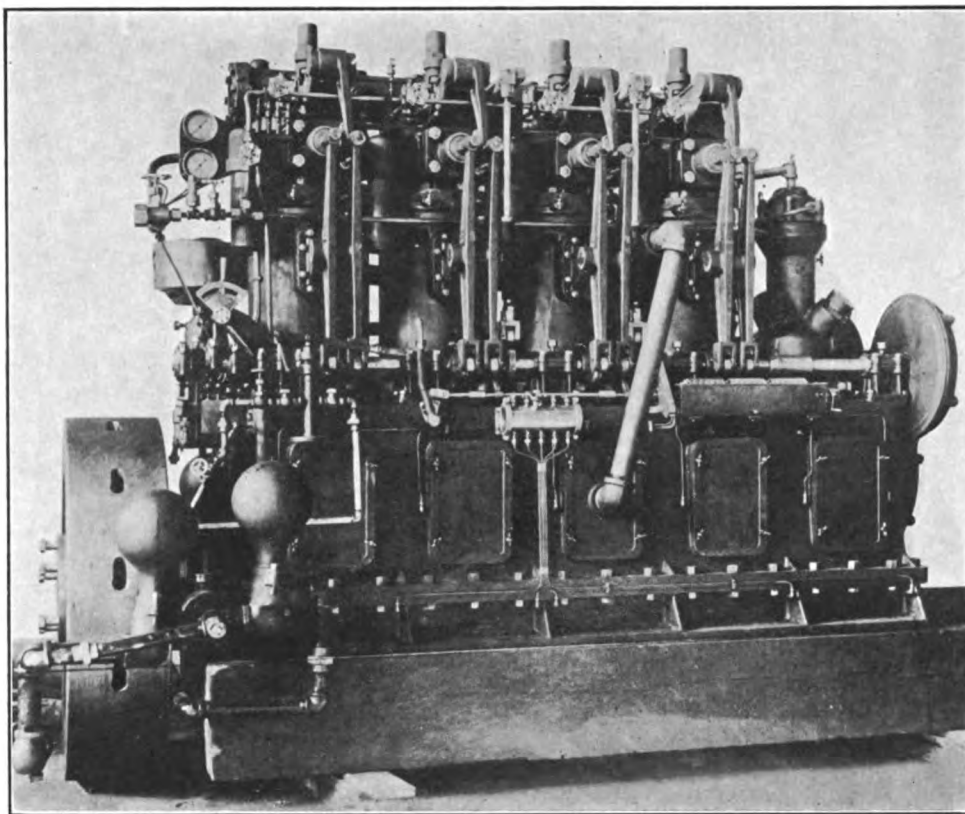


Fig. 2.—240 Horsepower Nlsec Engine for Tug *Chickamauga*

zontal, the inlet valve being located on the front side of the cylinder, the exhaust valves on back and both operated by rocker arms actuated by the cams on the cam-shafts, the cam shafts in turn being driven by spur gears from the crankshaft.

The spray or fuel valves are placed on top of the cylinder heads so that the charge enters the cylinder directly over the center of the piston, and these valves are also operated by rocker arms and bell-cranks which are actuated from the front cam-shaft.

The air-starting valves on the two inside cylinders are actuated by push rods from the front cam-shaft. The fuel oil pump is a noticeable feature and consists of four plungers, one for each cylinder, these being mounted in pairs on two eccentrics driven from the after end of the front cam-shaft. Furnishing a pump for each cylinder makes it possible to get a fineness of adjustment that gives high efficiency and unusual economy. Speed variation of the engine is obtained by the use of a throttle which cuts down the fuel supply to the cylinders, and a governor driven from the after end of the back crankshaft, which prevents racing by cutting off the fuel supply.

The circulating water is supplied by a plunger pump

located between the housing and flywheel and driven from the main shaft. This plunger pump is furnished in duplicate, and as only one is needed the extra pump provides a standby for emergency.

Air for the whistle is drawn from the starting air tank and passed through a reducing valve so that the pressure is lowered to about 125 pounds. This whistle air is stored in a galvanized whistle tank hung on the deck beams.

The engine is started by means of compressed air with starting attachments on two cylinders, so that as soon as started and on almost the first revolution, the remaining two cylinders begin to fire on oil, after which the starting gear is thrown out and starting cylinders then operate on oil.

The lubrication is by a positive circulating oiling system. The oil is supplied from a pump to a duct in the bottom of the bedplate. It then passes up through holes drilled in the bedplate to the main bearings, thence through holes in the crankshaft to the crankpins, and after that through the connecting rods to the wristpins. As the engine crank-pit is all inclosed, the flying oil is confined and drains back to a sump in the bedplate, where it is strained and used over again. A mechanical lubricator shown forward on the front of the engine and driven from the front cam-shaft is provided for oiling the cylinders. It

will thus be seen that the lubrication of the engine is substantially automatic, requiring very little attention from the operator.

At full power the engine burns only 12 gallons per hour of $2\frac{1}{4}$ cents ($0/1\frac{1}{8}$) California fuel oil, a cost of 27 cents ($1/1\frac{1}{2}$) per hour; lubricating oil, $1/7$ gallon, costs 6 cents ($0/3$) per hour. From this it is seen that the combined fuel and lubricating cost of her 240 horsepower Nlsec Diesel is only 33 cents ($1/4\frac{1}{2}$) per hour. During the first month the *Chickamauga* was in commission the consumption of fuel averaged about 6 gallons per hour,

which is, as the boat handled average tows, a quite remarkable showing.

One tow made by this boat was 150 miles when she had in tow a log raft made up of two booms of ten sections each. With this tow, both with and against the tide, the *Chickamauga* averaged a speed of two knots. Another tow of about 40 miles was made when she handled a double raft containing about 1,000,000 feet of very large cedar logs over 100 feet long and more than 3 feet thick at the butt, at a rate of two miles per hour and the engine developing full power at 240 revolutions per minute.

Marine Oil Engines for Commercial Work

Wide Application of Mietz & Weiss Oil Engines to Work Boats—Construction and Operation of the Engine

The long period of development and study in the production of an internal combustion engine which would combine the primary requirements of complete reliability with low fuel cost has resulted in the application of the Mietz & Weiss marine oil engine to a large number of working vessels. Because of the weight limitations imposed by shallow draft boats, this engine has found a particularly fertile field in this type of work. Its light weight

to four cylinders and from 2 to 80 horsepower. The weights of the different size engines complete run from about 120 to 175 pounds per brake horsepower, depending upon the speed and other characteristics.

The simplicity of operation of the Mietz & Weiss engine will be realized when it is known that the engine is entirely free from such auxiliary devices as electric ignition, carburetors, vaporizers, cams and cam shafts, gears,

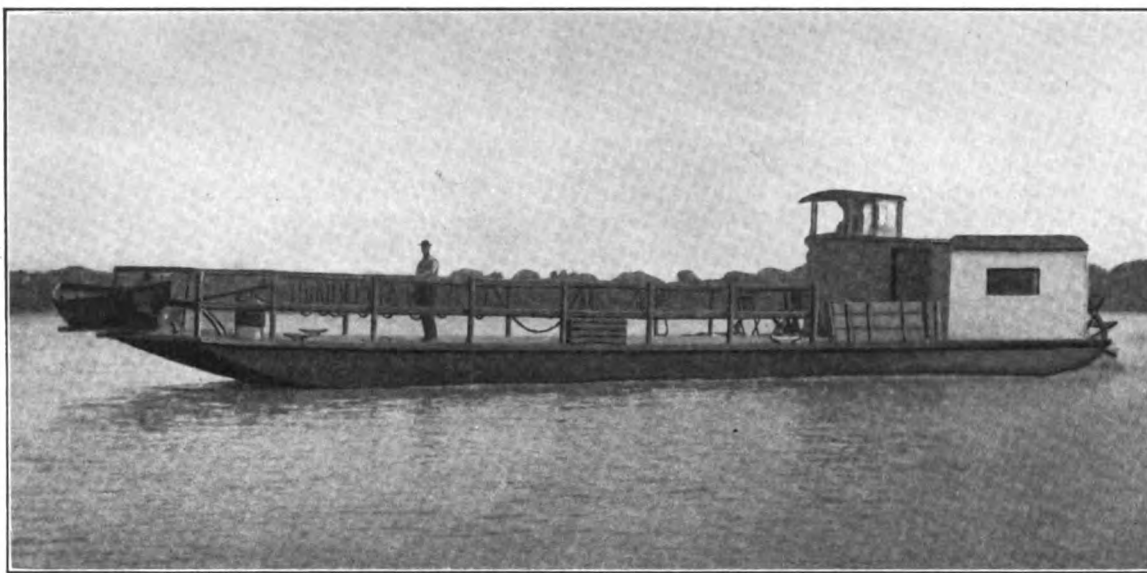


Fig. 1.—Shallow-Draft Ferryboat *Esperilla*, Propelled by 12-Horsepower Mietz & Weiss Oil Engine

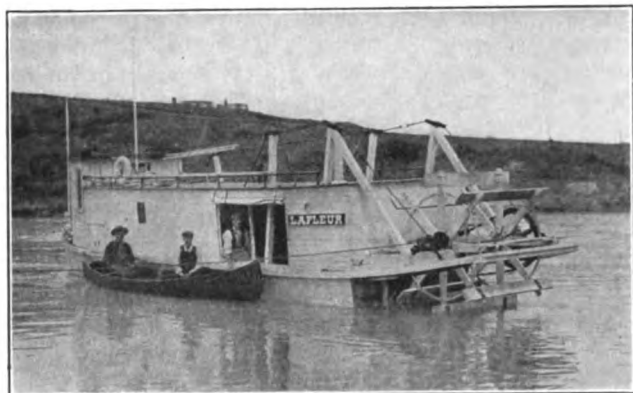
compared with the power developed, its economy in fuel, resulting in saving in necessary weight of fuel carried, and the total absence of cumbersome and heavy auxiliaries have made it ideal for this purpose.

It is quite evident that in any power-propelled vessel a saving in weight and space of propulsive machinery adds correspondingly to the amount of cargo which can be carried. This avoids carrying around a lot of deadweight at a definite cost. At the same time, it adds largely to the earning capacity of the vessel, and frequently would bridge the difference between operation at a loss and operation at a profit.

The engine is built both direct reversing and with reversing gear. The reversible type covers engines of three to six cylinders, in sizes from 45 to 600 horsepower. As fitted with reversing gear, the engines are built from one

valves, etc. The absence of carburetors or ignition devices takes away one of the largest causes of trouble in internal combustion engines, for it is estimated that about 90 percent of such troubles are due to these items. As the moving parts are confined to the piston, connecting rod, crank shaft, reversing device and the fuel pump controlled by the governor, it is evident that no successful power engine could possibly get along with less.

This is a two-cycle engine, so-called. The first Mietz & Weiss engine of this type was built in 1895, and is still in active service. As it has already given its owner twenty years of successful and constant service, the question of durability is at once disposed of. All of this is helped by the very small number of moving parts and consequent absence of adjustments. There is less wear, less breakage and fewer shutdowns; less attention and me-

Fig. 2.—Survey Boat *Lafleur*

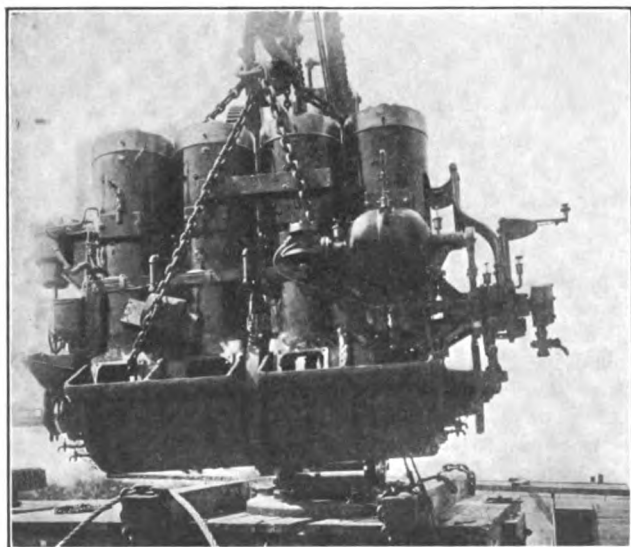
chanical knowledge required. This means an extremely low cost of maintenance.

Every downward stroke of the piston is a power stroke. The fuel is sprayed directly into the combustion chamber, shortly before the completion of the upward or compression stroke, thus avoiding all leakage of fuel through the crank case or exhaust ports. The amount of oil injected is proportioned to the load by the governor, which is so adjusted that the engine cannot race, even should the propeller or shaft break.

The utility of the reversible engine is self-evident. Both this type and that with reversing gear may be installed for control from the pilot house. On a small boat this makes it possible to operate with one man. In any case, the care of the engine requires only a small part of a man's time, leaving him free for other duties. And, of course, there are no "standby" losses.

The Mietz & Weiss oil engine has been operating for years on low grade oils, using about 0.6 pound for horsepower hour. Kerosene (paraffin), fuel oil, distillate, crude oil or alcohol may be used. As gasoline (petrol) is never used in these engines, one very prolific source of danger is avoided. The lack of exposed gears, cranks and cam shafts means safety for the operator. All parts are designed with an unusually high factor of safety, and with special attention paid to balance in order to prevent vibration.

As the compression pressure is very moderate, this en-

Fig. 3.—100-Horsepower Direct-Reversible Oil Engine Installed in the *Santiago*

gine avoids the severe stresses, excessive bearing pressures, and lubricating troubles from which engines with high compression suffer. The troubles so common to engines which rely upon the heat of compression to ignite the charge are wholly unknown in the Mietz & Weiss engines. These facts are largely responsible for their record of reliability.

Among the shallow draft craft operated by this type of engine, we show a picture of a ferryboat run by Esperilla Hermanos at Cartagena, Colombia. This ferry is operated by a 12 horsepower engine, driving a paddle wheel aft. The illustration shows how the entire equipment is contained within the small deck house with its raised pilot house. Everything is under the control of one man in the pilot house. This craft is fitted for handling passengers, teams, etc.

Another illustration shows the survey boat *Lafleur*, also driven by a Mietz & Weiss oil engine, operating a stern wheel through chain and sprocket. The motive power in this case is a 15 horsepower, two-cylinder engine, located

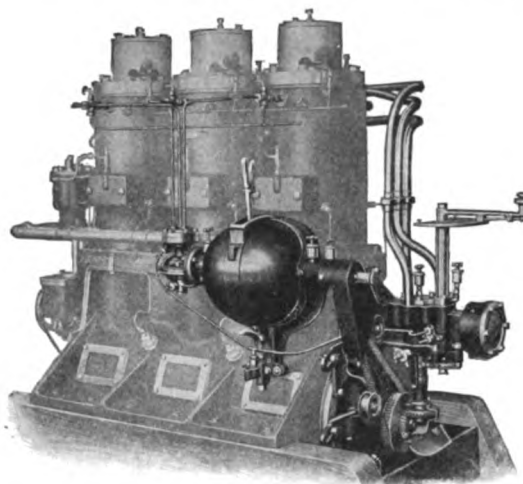


Fig. 4.—The Mietz & Weiss Direct-Reversible Engine, S & W Reversing Valve, M & W Governor and Oil Distributor

just inside the stern of the deckhouse. The vessel is used in the Saskatchewan district of the Canadian Northwest.

The third illustration shows a four-cylinder, 100 horsepower, direct reversible oil engine being installed in the freight and passenger vessel *Santiago*, which runs between Cartagena and Tula, Colombia. This is owned by L. Pocater & Co., and operates for a distance of one hundred miles on the Sinn River. The vessel measures 110 feet in length by 23 feet in beam, and when loaded draws 6 feet of water. She is listed at 90 tons. The engine, which weighs 11,050 pounds, has an overall length of 9 feet 5 inches, with a width of 3 feet 7 inches and a height above foundation of 6 feet 4 inches. It runs at 340 revolutions per minute.

The reversing gear of the Mietz & Weiss engine is of extremely simple but rigid construction. When the engine is running ahead the gears are idle and power is transmitted direct to the propeller shaft through a solid coupling. When the gears are thrown in they are locked in proper position, and as they run in oil and are enclosed in an oil-tight casing the friction is reduced to the lowest possible point. The propeller thrust in either direction is taken up by large roller thrust collars.

The S & W distributor fitted to this engine is standard on all the larger marine equipments with three or more cylinders. It makes the control of the engine extremely simple. The lever at the right controls the direction of

operation of the engine, and at the same time positively controls the fuel injections by varying the opening in the inlet valve. In the meantime, the engine speed is controlled by the throttle on the governor, which is shown in the center of the illustration.

The S & W distributor is a rotary valve with a positive drive from the main engine shaft. It controls the flow of air from the pressure tanks to the cylinders, to give proper initial rotation in either direction, at the will of the operator. At the same time, it solves very nicely the control

the Dahl oil burning system being installed. Her engines were built by the Hefferman Engine Works of Seattle, Wash., and have cylinders 10 inches, 17½ inches and 28 inches diameter by 18 inches stroke, driving a bronze wheel 8 feet 3 inches diameter, which, at 180 revolutions per minute, gives the vessel a speed of 9 knots.

The vessel is complete in every department and has a derrick boom operated from her foremast capable of lifting three tons for use in handling buoys. A double drum, two-cylinder steam hoist located in the forward hold, op-



Light House Tender *Fern* for Alaskan Coast

of the oil injections when reversing the engine. These injections are stopped positively as soon as the controlling lever is moved to reverse or stop the engine. This allows compressed air to enter the cylinders and start the engine rotation in the opposite direction. As the oil supply is cut out by this movement, the engine can receive no more oil until it again starts to run in the direction called for by the movement of the lever.

This engine, in a number of varying sizes, has recently been fitted to United States light ships, both on the Coast and on the Great Lakes. The question of extreme reliability becomes here one of the greatest importance. In all, the United States Government Service has 144 Mietz & Weiss engines. The builder is August Mietz, 128 Mott street, New York City.

Light House Tender *Fern*

To meet the needs of the newly created sixteenth Light House District, the United States Light House Department has had built by the Hall Brothers Marine Railway & Shipbuilding Company, Winslow, Wash., a new light house tender called the *Fern*, which was placed in commission last June and is stationed on the coast of Alaska, with headquarters at Ketchikan. The vessel is small, being but 112 feet overall by 22 feet beam and 10 feet depth of hold. Her displacement is 225 tons on a mean draft of 7 feet. She is framed with white oak and planked and ceiled with Oregon pine and fastened with copper through-out.

Her power plant consists in an Almy watertube boiler having 1,780 square feet of heating surface, built for a working pressure of 200 pounds. Oil is used for fuel,

erates the derrick boom lifting gear, and is controlled by a bank of levers located on the forecastle deck.

The cost of the vessel complete and ready for sea was \$90,000 (£18,500).

Modern Self-Propelled Barge for the Mississippi River

The Inland Navigation Company, of New York, is having built by the Howard Shipyards Company, Jeffersonville, Ind., a self-propelled steel barge 240 feet long and 43 feet extreme beam, with a carrying capacity of 1,600 tons of freight on a maximum draft of 7 feet. This barge is the first of a fleet which the owners plan to place in regular service on the Mississippi River between New Orleans and St. Louis.

The barge is all steel, with the hold divided into five compartments by means of four watertight bulkheads. Propulsion is by four four-cycle, three-cylinder oil engines, built by Fairbanks, Morse & Co., each operating one propeller. At a draft of 3½ feet the barge can carry 500 tons, and at its maximum draft of 7 feet it can carry 1,600 tons.

As can be seen from the illustrations, the barge is covered with a steel waterproof cargo box and equipped with an electric traveling crane which, with a boom extended outward on either side for 70 feet, is capable of lifting one ton. The barge is further equipped with a duplicate electric power plant for heating, cooking and lighting. The bow and stern each are provided with 4 horsepower electric winches, the steering is done by electricity and the pilot house is completely equipped with all modern conveniences, such as a mechanical telegraph, telephones, and in addi-

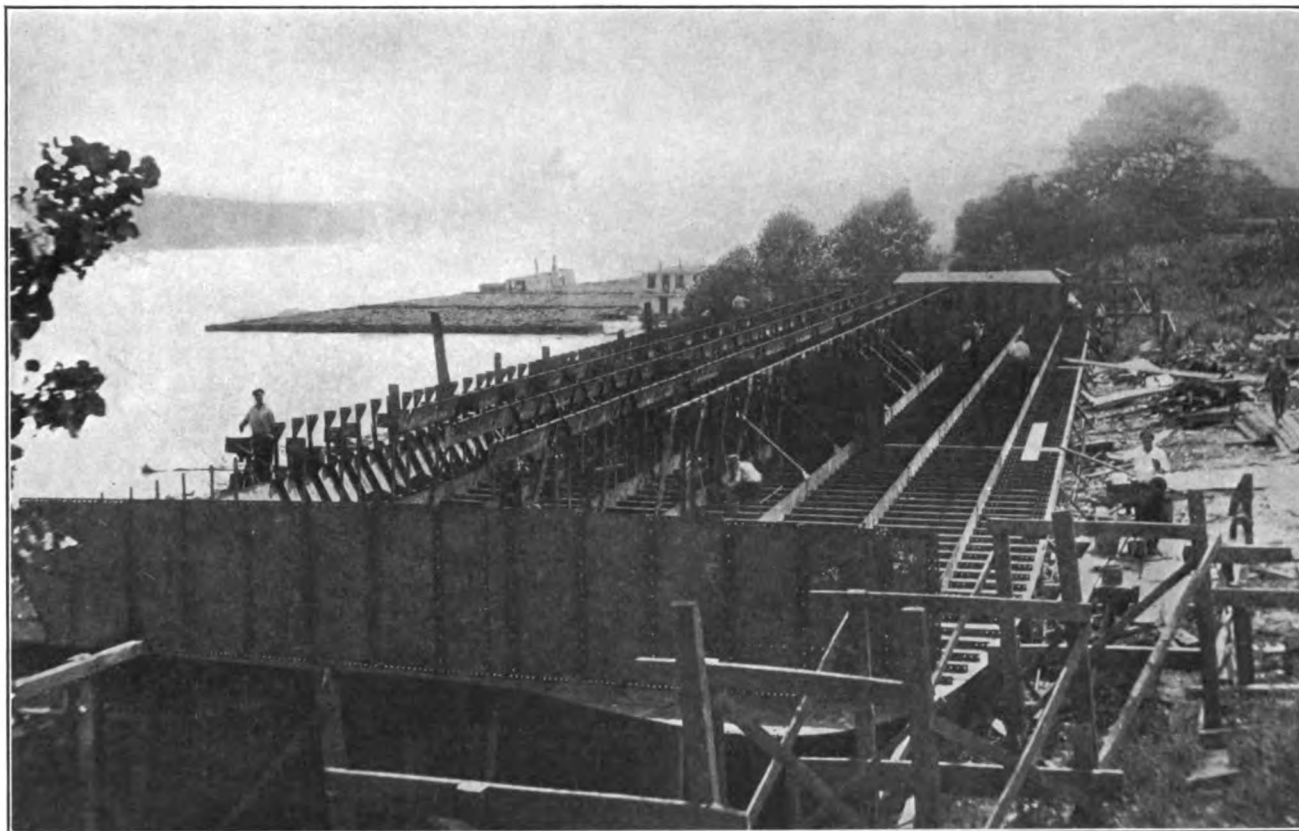


Fig. 1.—New Barge for Inland Navigation Company, Under Construction at the Howard Shipyards, Jeffersonville, Ind. The Barge is 240 Feet Long and 43 Feet Extreme Beam, with a Carrying Capacity of 1,600 Tons of Freight on a Draft of 7 Feet

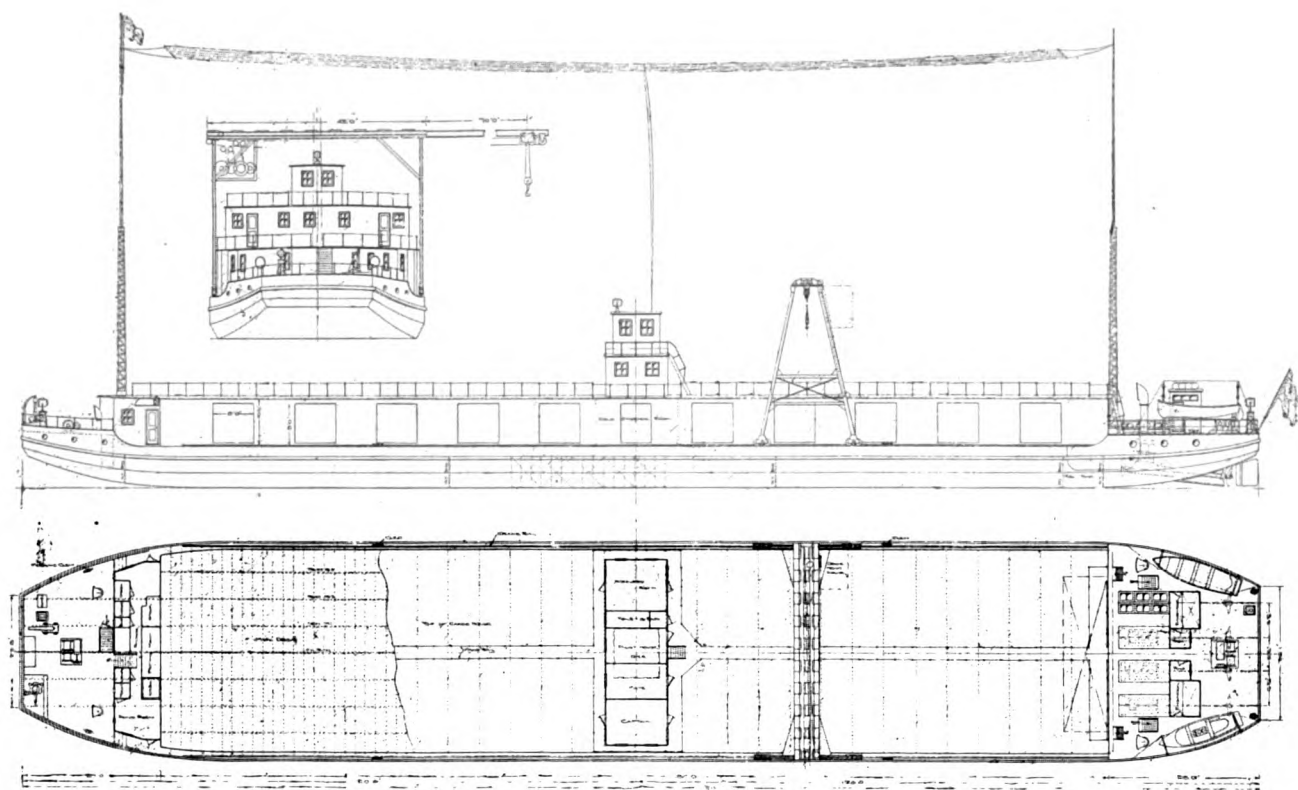
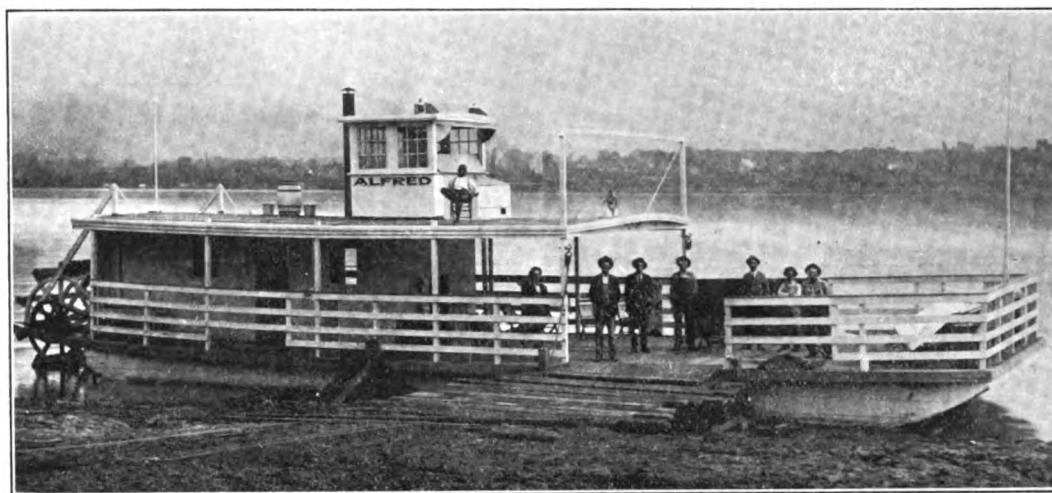


Fig. 2.—General Plans of Quadruple Screw Steel Barge with Housed-in Cargo Space and Traveling Crane for Handling Freight. The Barge Is Propelled by Four 80-Horsepower Oil Engines, and Is Equipped with Electric Plant and Wireless Outfit

tion a wireless outfit. Two 5-inch centrifugal pumps, electrically operated, are connected to the bilges and ballast tanks. Two refrigerating plants are to be installed, one for the crew and one for the cargo, capable of maintaining a temperature of 35 degrees for a cargo of 6,000 cubic feet.

Stern Wheel Motor Ferry Boat on the Ohio River

An unusual type of ferryboat is operated on the Ohio River at Metropolis, Ill. The boat is named the *Alfred* and was built by its owner, Mr. Thomas E. Cutting, of Metropolis. It is 60 feet long and 20 feet beam, with a depth of hull of 3 feet. Power for operating the boat is derived from a 28-horsepower, four-cylinder Clifton gasoline (petrol) marine engine, which through bevel gears, a cross shaft and sprocket wheels drives a paddle wheel at the stern 8 feet diameter and 11 feet long, fitted with ten buckets. Reversing is accomplished through a marine



Stern Wheel Motor Ferry *Alfred*

engine reverse gear at the engine. The engine was built by the Clifton Motor Works, Cincinnati, Ohio, which is the gas engine department of the Carlisle & Finch Company.

Light Draft Tunnel Boat

The river boat *Margery 3*, illustrated herewith, is of tunnel stern construction 55 feet long, 12 feet beam and 30 inches depth, built by the Rippley Mfg. & Steel Boat Company, Grafton, Ill. The hull is of 10-gage galvanized steel plates with frames of 3-inch channels spaced 15 inches apart. Propulsion is by two 20-horsepower and one 50-horsepower gasoline (petrol) engines, the draft of the boat being 22 inches.



Shallow Draft Tunnel Boat *Margery 3*

Foundering of Steamer *Edith*

The steamer *Edith*, carrying a cargo of copper concentrates from Latouche, Alaska, to Seattle, Wash., was abandoned on August 30 in the Gulf of Alaska without loss of life. Copper concentrates are shipped in the form of mud and in heavy weather this is an extremely dangerous cargo. When this cargo shifts, throwing a ship on her beam ends, it is impossible to either trim cargo or right the vessel. The *Edith*, carrying 2,800 tons, encountered very tempestuous weather, and when her cargo shifted the steamer was left in a very precarious predicament.

Efforts to right the vessel were futile, and as the stormy weather continued it was determined to abandon her. It was too rough to board the lifeboat alongside, so the small boat was rowed some distance away and officers and crew were compelled to leap from the *Edith* and swim for the lifeboat. A few hours later the survivors were picked up by the passenger steamship *Mariposa*.

Attempts to tow the *Edith* to shelter failed and the vessel was left to her fate. She was photographed just at sunset as she was ready to plunge to the bottom of the Gulf of Alaska.

The *Edith* was one of the largest freighters operating



"Her Last Sunset"

out of Seattle to Alaska. She was built at Sunderland, England, in 1882, and has been on the Pacific coast for nearly twenty years, most of this time operating between Seattle and Bering sea ports.

The ship was valued at \$200,000 (£41,000) and the cargo at about \$275,000 (£56,500).

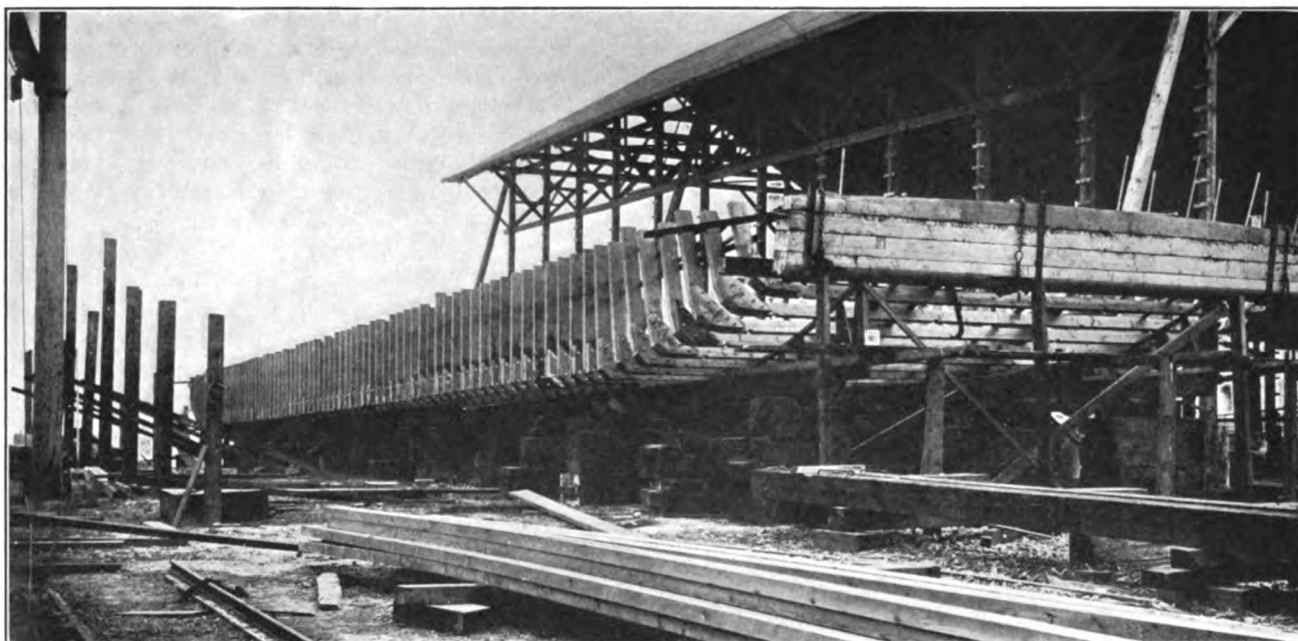


Fig. 1.—Hull of Government Shallow-Draft Snag Boat *Swinomish*, Under Construction at the Yards of the Hall Brothers Marine Railway and Shipbuilding Company, Winslow, Wash.

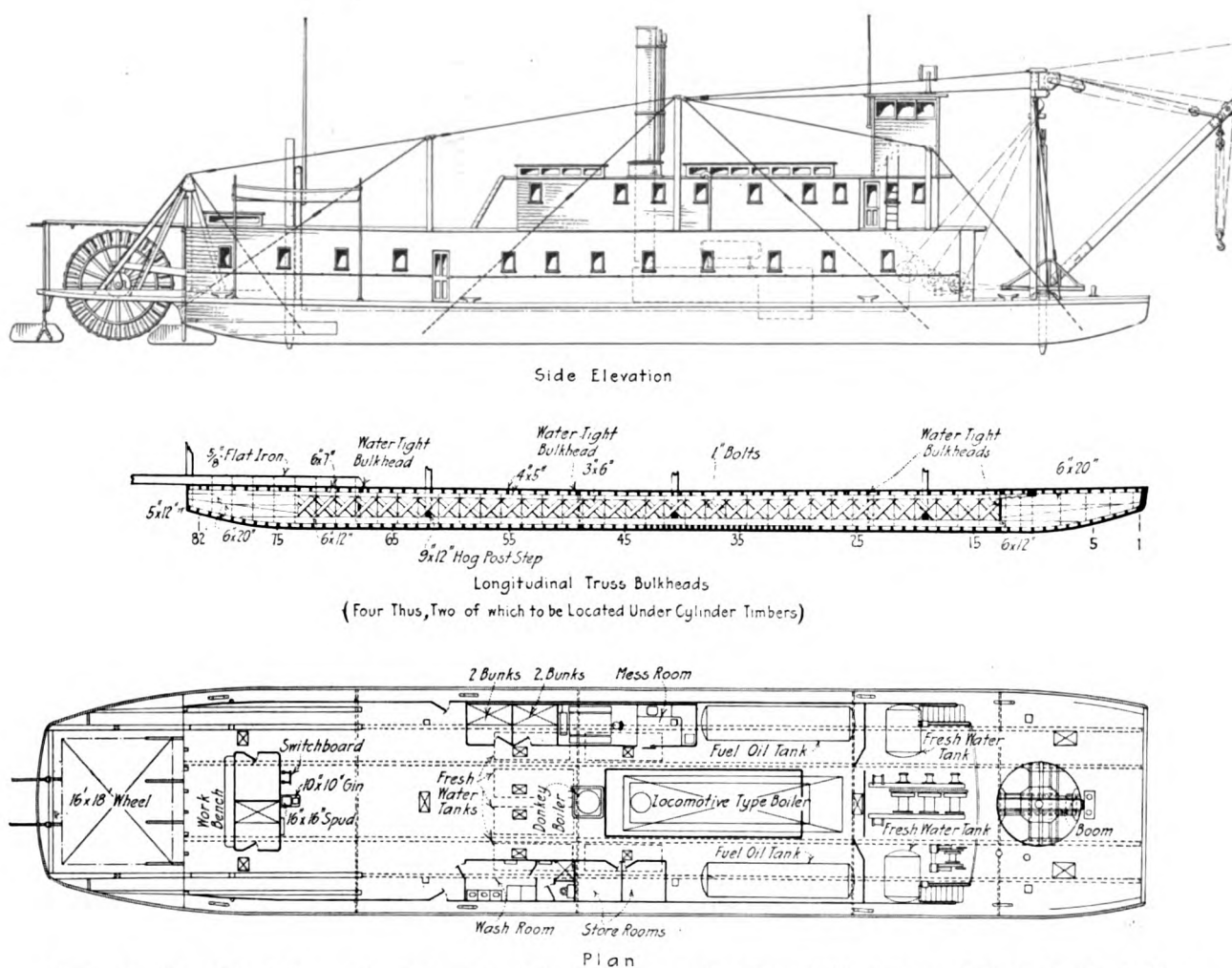


Fig. 2.—Profile and Deck Plan of the *Swinomish* and Section of Longitudinal Truss Bulkhead, Four of Which Are Fitted, Two Under the Cylinder Timbers

Shallow Draft Snag Boat Swinomish

Government Boat Built at Winslow, Wash., for Use on the Rivers and Harbors of the Puget Sound District

The Hall Bros. Marine Railway & Shipbuilding Company, Winslow, Wash., has built for the Engineers' Department of the U. S. Army, Department of Puget Sound, the shallow draft, stern wheel, snag boat *Swinomish*, for use on the rivers and harbors of the Puget Sound district to remove snags and other obstructions to navigation. The boat is equipped with heavy snagging gear operated from an A frame and derrick boom capable of lifting 75 tons, mounted on the forward part of the boat. She is also equipped with clam-shell dredging bucket of 2 yards capacity

The scantlings of hull are as follows: Floor timbers, 4 inches by 7 inches, spaced 20 inches and doubled beneath the boiler; side frames, 4 inches by 8 inches; deck beams, 4 inches by 5 inches; beam clamps, 4 inches by 10 inches; bilge stringers, 4 inches by 10 inches; bottom planking, 3 inches by 10 inches; side planking, 3 inches by 10 inches; deck planking, 2½ inches by 6 inches. Triangular oak blocks are fitted at the knuckle of the frames connecting the side to the floor frames.

The engines were manufactured by Gillette & Eaton, of Detroit, Mich., and are 14 inches diameter by 72 inches

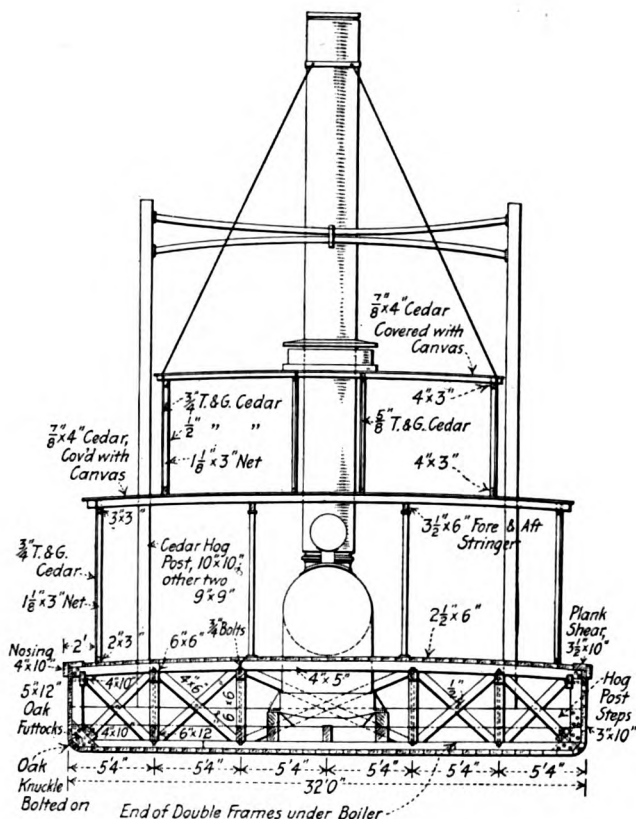


Fig. 3.—Midship Section

which is used for dredging purposes on the shallow river bars, etc., in keeping the channels open.

The hull is of the barge type with rounded rakes fore and aft, extending about 20 feet from the ends, and has the deck slightly narrower at the ends. The hull is strengthened fore and aft by four longitudinal truss bulkheads of bridge type construction of X braces without posts. Cast iron bridge sockets placed on the keelsons and under deck stringers receive the ends of the braces and a vertical tie rod extending through the sockets, keelson and deck stringer, constitutes the plan of the bulkhead. This is rather a departure from the usual type of truss bulkhead as used in vessels of this type. There are three athwartship watertight bulkheads.

The house is built of light framing and sheathed with cedar in order to minimize the weight of upper structure. There are accommodations for 16 men, those for the crew being on main deck and those for the officers on the upper or cabin deck.



Fig. 4.—End View, Showing A-Frame and Derrick Boom

stroke, designed for a working pressure of 200 pounds. The boiler is of the locomotive firebox type. Oil is used for fuel and ample storage tanks are located on the main deck at sides of boiler. The Dahl oil burning system is used.

The electric light plant consists of a General Electric Company's generator direct connected to a vertical engine. The generator is a 7 kilowatt, 110 volt machine and is connected for supplying lights direct from the generator when steam is up, and is also connected to two sets of Edison storage batteries from which light is supplied when steam is down. A 1,600 candlepower searchlight is mounted on top of the pilot house.

As the vessel has to navigate many rapid, tortuous streams where rapid handling of her rudder becomes necessary, a specially designed combined steam and hydraulic steering engine, designed and built by the Washington Iron Works of Seattle, Wash., has been provided. This consists of one steam cylinder and one water cylinder mounted on one frame, with the two cylinders facing each other at its ends. One piston rod connects to the pistons in both cylinders and has a double shive housed

in the center of same sliding on cross head guides. The tiller ropes connecting to the rudders and to the steering wheel in the pilot house pass around these shives, one from each side of the ship in their lead from the rudders to the pilot house. When it is desired to use the steering engine the steering wheel in the pilot house is locked secure in a midship position and power is applied to the steering engine, which rapidly throws the rudders through the action of the pistons and shives on the bight of the tiller ropes. When it is desired to use the hand-steering gear in the pilot house, the operation is reversed in locking the pistons in a central position when the shives serve simply as idlers on the tiller ropes, as they are operated by the hand-steering wheel. The vessel is equipped with

four main rudders located at the stern forward of the wheel, and two monkey rudders located abaft the wheel, all connected by tillers to the one quadrant.

The vessel was built under the direction of Major J. B. Cavanaugh, Chief of Engineers for the U. S. Army in this district, and cost complete about \$55,000 (£11,300). On an endurance run of eight hours at the time of the vessel's acceptance by the department, she made an average speed of 9 knots and handled admirably in every appointment. This type of hull is cheaply constructed and would be well adapted for freight purposes where a shallow draft vessel is required. Her draft when launched was 13 inches, and with all equipment aboard and fuel and water tanks full, her draft is 2 feet 11 inches.

Modern Submarines in War and Peace—V

Construction and Installation of Storage Batteries—Tactics of the Submarine in Warfare—The Invisible Weapon

BY SIMON LAKE *

It is impossible in an article of this character to go into much detail regarding the development of the storage battery. There have been two types in general use. They are both lead batteries, one known as the Plante type, in which metallic lead is used to form both the positive and negative plates. The other type employs what is commonly known as pasted plates, in which various compositions of materials are worked up into a paste and forced into metallic grids to form the positive and negative plates. The pasted type has greater capacity per pound of material used, but much shorter life.

In both of these batteries sulphuric acid solutions are used as the "excitant" between the elements. In charging, hydrogen gas is given off in the form of bubbles, the skin of the bubbles being composed of sulphuric acid solution. These bubbles, when taken in one's lungs, are very irritating, and if they collect in any quantity, or break up and allow the hydrogen gas to mix with the air, there is always danger of creating an explosive mixture within the hull of the vessel or in the battery tanks, which a spark would set off at any time.

INSTALLATION OF STORAGE BATTERIES

The best method of installing batteries on a submarine boat is to have them isolated from the living quarters of the vessel in separate watertight compartments. The elements of the battery should be contained in non-metallic containers and sealed to prevent spilling of the electrolyte under excessive rolling or pitching of the vessel. Means should be provided to discharge the hydrogen gases from the boat as rapidly as formed. Special care should be taken to prevent leakages between the adjacent cells. Circulation of air to keep the cells dry is the best means of preventing this.

Mr. Edison has been working for a number of years on a storage battery suitable for submarine work, and it has recently been stated that he has finally solved the problem of producing a battery that will stand up longer than the lead type of battery, and that it has the further advantage in that it will not give off chlorine gas in case

salt water should get into the cells. It should, however, be contained in a separate compartment, which should be ventilated during the charging period, as I understand the Edison battery gives off hydrogen gas the same as the lead batteries. Chlorine gas, as given off from the lead battery when salt water has got into it, has undoubtedly caused the loss of some lives.

Mr. Edison claims that his battery will not give off poisonous gases of any kind when immersed.

TACTICS OF THE SUBMARINE

The submarine boat is the guerrilla in warfare. Its tactics, therefore, are the tactics of the Indian who fights under cover, or lies in ambush for his enemy. This is necessarily the tactics of all weaker individuals, and is an essential method of procedure to prevent the weaker party from being annihilated by the strong and more powerful.

Some people have contended that the submarine is an unfair weapon, but the old statement that "All is fair in love and war" applies to the submarine as it does to every weapon that has been invented since the days when men struggled for supremacy with their bare hands. The first man who wielded the club might have been accused of being unfair; the same with the man who invented the sling shot, or the bow and arrow. When people fight for their existence, the existence of their families or their country, they do not fight according to the "Marquis of Queensberry Rules." A revolver in the hands of a weak man or a defenseless woman is a proper weapon to enable them to protect their property, their honor, or their life; and no matter what theorists may claim, the submarine will remain as a weapon to be reckoned with in all future wars, provided there are future wars upon the high seas, which I much doubt, as I believe the great lesson that is being rapidly taught by this war is that no country can longer claim to be the "Mistress of the Sea," and that when two countries cannot agree they must consent to give up all commerce with other nations until they can agree.

The lesson to be taught by the submarine cannot be learned in a one-year course. It will, in fact, require several years to teach the militarists—that is, the naval

* Member of Institution of Naval Architects (England), Schiffbau-technische Gesellschaft (Germany), Society of Naval Architects and Marine Engineers (United States) and American Society of Mechanical Engineers.

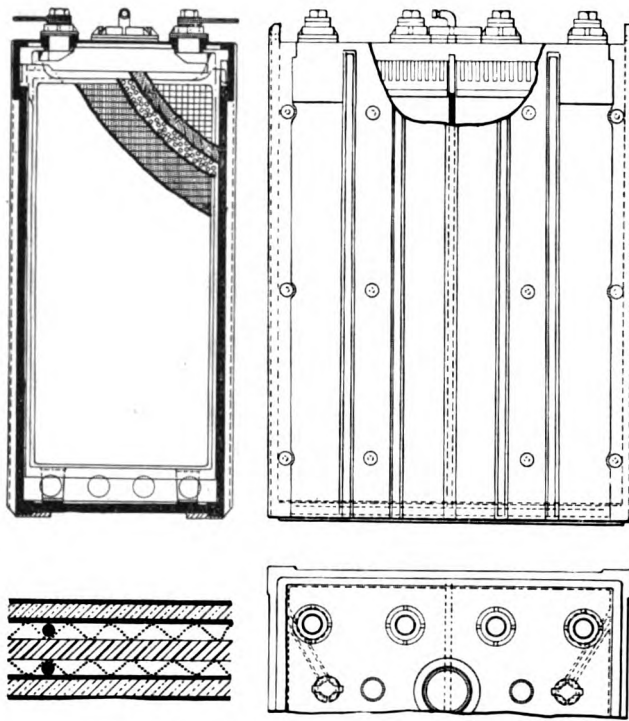


Fig. 42.—Storage Battery Cell

Storage batteries as used in modern submarines have been especially developed to meet the special needs of submarine-boat service. The requirements for this service are much more severe than those for any other service to which the storage battery has been applied. The batteries as first introduced in submarines were entirely too frail to stand up to their work, and the gases given off from them while being charged were the cause of much distress and danger to the crew, and have been in some cases responsible for the loss of both vessel and crew.

The above views illustrate a modern storage battery cell as developed by one of the largest of the German battery manufacturers; it was built under instructions from the author to overcome certain objections referred to in the text. The cell is composed of a hard rubber outer casing with a sealed cover, a large view of which is shown in Fig. 43.

The cells give off gas only during the charging process. Before charging is begun exhaust fans are started which draw the air down through plugs distributed over the top of the cells. This dilutes the gases as rapidly as formed, and the gas is drawn out through a central filter box, as indicated by the arrows in Fig. 43. This filter box is arranged in such a manner as to break up the bubbles so that only the air and gas is drawn out, the electrolyte returning into the cell. The gas then enters the main duct, passes through the exhaust fan and is discharged overboard. This keeps the battery compartment free of gas and dampness, which was common in previous installations, due to the breaking up of the electrolyte bubbles.

militarists—that there is no escape from this invisible Nemesis on the high seas. It is impossible to fight with the invisible. It is this invisibility which differentiates the submarine from all other weapons of offense or defense that have ever been invented. Mr. Holland, years ago, called attention to the fact that submarines cannot fight

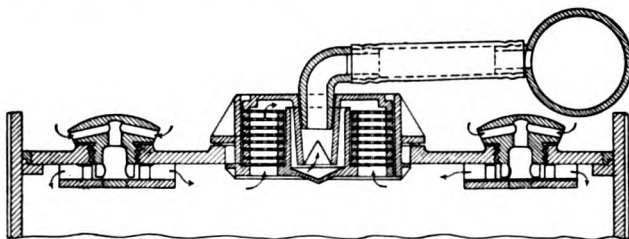


Fig. 43.—Enlarged View of Cell Cover

submarines. The present war has proved this to be a fact. The North Sea and the English Channel have been infested with submarines of the German, English and French fleets, yet in no case, as far as I am aware, has one submarine succeeded in destroying another. It is probably true, as was reported, that an Austrian submarine sank an Italian submarine, but according to the reports of



Fig. 44.—A Submarine Cell Completely Assembled Ready for Installation

Formerly the plates were assembled and burned to the bus bar within the boat. Now the practice is to assemble the cells complete and with special cell lifting clamps they may be readily installed. The author has had cells of this type built in Southern Germany charged with electrolyte and shipped to Petrograd and installed there in boats complete.

this encounter the Italian submarine was in surface cruising condition. She was, therefore, not at that time a submarine vessel, and of course was visible to the commander the same as any other surface vessel is visible to the submarine when within range of vision of its periscope.

The difficulty of locating an object like a large vessel when sunk beneath the surface of the sea is so great that in some cases years have been spent in trying to locate them, even in comparatively shallow water, and even though they were known to have been sunk within a short radius of a given point. The writer has spent some years in the study of this problem in connection with the wrecking business. A few illustrations on this point may make clear to the student of this problem what a fallacy it is to contend that a submarine might be detected by a surface vessel or an aeroplane except in shallow waters, and in such localities where the water is very clear.

One case in point is that of the *Rio de Janeiro*, sunk in San Francisco Bay in 1900. This vessel contained, it is reported, a valuable cargo of about \$500,000 (£102,500) in gold. Although search was made for her, covering a period of many months, she was never located. I remember another case, that of the steamer *Cayuga*. This vessel was sunk in collision with another vessel within a short distance of a lighthouse. The lighthouse keeper saw her when she went down. The steamer with which she was in collision anchored immediately and took ranges as to her location. Although the depth of water was only 120 feet and the *Cayuga's* masts extended 117 feet from her keel, nevertheless an experienced wrecker with his crew of searchers worked two months before they succeeded in locating her.

Another case on which I, personally, spent considerable time was that of a vessel, loaded with copper ore and copper matte, sunk in Long Island Sound. This vessel was seen to disappear one afternoon between Falkners

Island light and Guilford, Conn. The lighthouse keeper took a range as to where he saw her disappear, and carpenters working on the roof of a house on the mainland at Guilford also took a range as to where they saw her disappear. As she had a valuable cargo, one of the largest wrecking companies in the United States was engaged by the insurance companies to locate her. They spent several months in the endeavor. The bottom where she sank was rocky, which made search by the old-fashioned sweep-line method very slow and uncertain. They abandoned the search and another wrecking company, on its own responsibility, undertook to locate her, since "findings is keepings" after a vessel has once been abandoned. They also failed, and then an old, retired wreck-master took up the job and spent two years in the endeavor to locate her. Even he did not succeed. About this time I brought the *Argonaut* up into Long Island Sound, and hearing of this rich prize, made the attempt myself to locate her and failed with the methods then in vogue. I also found that in our Northern waters it was impossible to see any considerable distance from a submarine boat, even with powerful searchlights. This brought about the invention of special wreck-finding boats with appliances for locating sunken vessels, which increased the speed of searching for under-water objects to a very great extent.

We finally succeeded in locating the copper wreck in 94 feet of water, but that was a case in which no attempt was made to prevent the vessel being located. A submarine fitted with guard arms to prevent a line catching on any projection thereof, so as to permit it to creep into an enemy's harbor, or to lie in wait off the entrance to a harbor, cannot be located even with the means which I finally found successful in locating an ordinary sunken ship. I do not know, nor do I believe, that there is any device that can be found which will locate a sunken object like a submarine especially fitted to prevent her detection in any of our Northern waters where the water is at all turbid.

The idea that a submarine boat may be located by an aeroplane is a fallacy, except in water of crystal-like clearness. In the clear waters of the Mediterranean or the Caribbean Sea it might be possible to locate a submarine in this manner, but the aeroplane's chance to destroy her would be very slight indeed, as the aeroplane must come directly overhead to locate or to drop a bomb on the submarine. Periscopes are now being built so that the heavens, as well as the horizon, may be scanned. The head of a periscope is an object only 4 inches to 5 inches in diameter, and when painted a neutral tint it cannot be seen with the naked eye (when at rest) a distance of over 500 yards. If the sea is a little choppy it is difficult to discover it at a distance considerably less than 500 yards. Nevertheless, the commander beneath the sea, with his telescopic sights, has a range of vision of several miles. A submarine lying at rest, therefore, off the entrance of a harbor, could readily detect an approaching aeroplane before it would succeed in getting a position where the outline of the submarine could be seen, even in clear water, as one must be almost directly overhead to see through the water, since the surface of the water acts as a mirror and deflects the line of vision.

Should an aeroplane be sighted, there would be two courses open to the commander—one to submerge deeper, and the other to come to the surface and with his rapid fire guns attack the aeroplane. In a battle between the comparatively heavy guns carried by the submarine and the light gun carried by the aeroplane, there could be only one result, as the gunner on the submarine would be firing from a stable platform, while the man in the aeroplane would be firing from a rapidly moving, unstable

platform, and the chance of getting sufficiently near to drop a bomb on the submarine would not be one in a thousand.

Experiments in dropping imitation bombs on outlines of battleships drawn on the ground have proved how difficult it is for an aeroplane to drop a bomb on a vessel covering as large an area. The maneuvers have been tried in peace times with no one shooting at the aeroplane, yet the chance of their making a hit from a height within the range of an ordinary rifle has been proved to be very slight; thus the aeroplane is not a menace to the submarine.

It is reported that the English have captured a number of the German submarines in nets off the entrances of harbors in different localities in the English Channel. It is reported that these nets are carried by floats which lie practically level with the surface of the water, and cannot be seen from the periscope of the submarine. Some of the newspaper reports would lead one to suppose that submarines were being caught in these nets like herring. One statement which attracted my attention was that a double line of these nets extended from the English to the French coast, all the way across the Channel. These lines were patrolled by high-speed surface boats or destroyers with rapid fire guns, grapnels, etc., so that when a submarine ran its nose into the meshes of the net and became "gilled," so to speak, the destroyer would rush to the spot where they saw the float of the nets disappear, and either grapple the submarine and bring her to the surface or lower bombs down on her and destroy her.

It may be true that a device of this nature might have been used successfully where the submarine was not fitted to prevent her being caught in the meshes of a large net; but it would be possible to provide the submarine with devices for cutting the submarine free of the netting or guards which would prevent entanglement in them, so that if nets are to be strung all around the coast line of the country to prevent submarines entering through such lines, we may expect to see devices provided to destroy the nets. A submarine fitted with bottom wheels and guards can under-run a net without difficulty. A guard could also be provided that would readily overrun such a net. Anticipating that such devices might be used in the effort to thwart the object of the submarine, I have designed a type of vessel which I call a "mine-evading" submarine, which I believe can pass through any obstruction except, perhaps, a stone breakwater.

In 1901 I submitted to the United States Government three distinct types of submarines. The first was a small type of vessel designed to be carried on the davits of a battleship or cruiser; the second was what I called a harbor and coast defense type, and the third was what I called a cruiser type, and was designed for offensive as well as defensive warfare.

In 1905 I prepared plans for a mine-laying submarine for submission to the Russian Government, a general description of which was published in 1906. This submarine was designed to carry thirty-six of the regulation naval mines, which could readily be placed in a desired locality while the submarine was entirely submerged. A vessel of this type might be useful for either offensive or defensive purposes. Where used for offensive purposes the mine-laying submarine could readily, with comparatively little danger to herself, plant mines off entrances to the enemy's harbor. Equipped with the "mine-evading" guards, they might even work their way into an enemy's harbor and plant mines under a vessel at anchor, or destroy shipping lying tied up at the docks. For defensive purposes, a mine-laying submarine would be of great value, as it could readily plant mines, even under

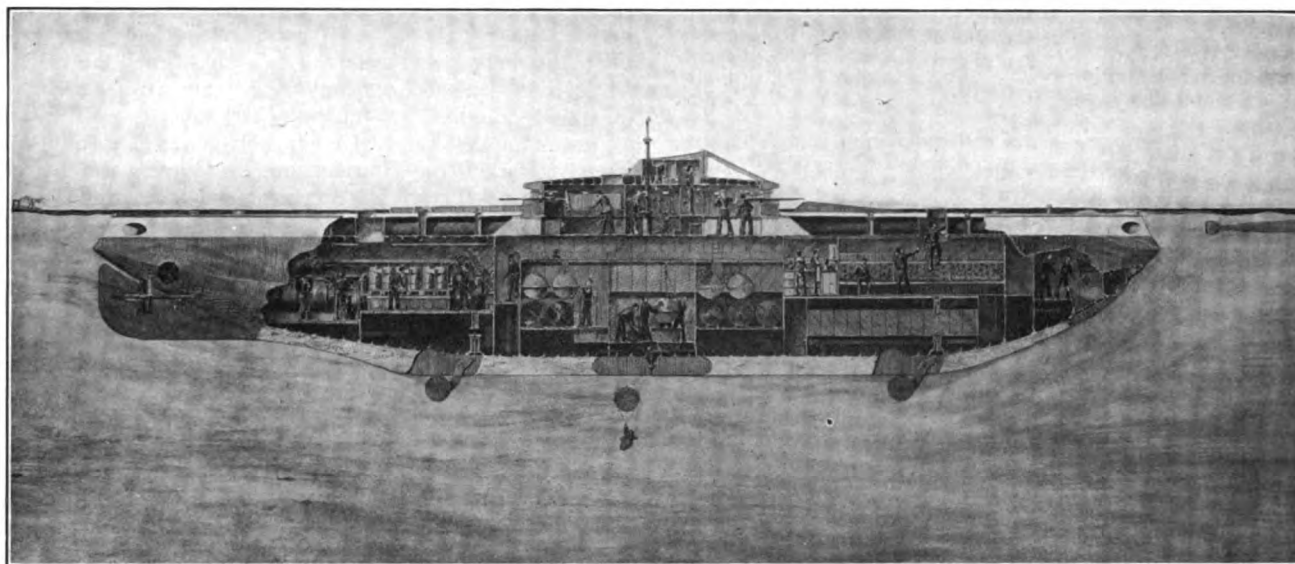


Fig. 45.—Mine-Planting Submarine Designed by the Author in 1895 in Berlin, Germany, for the Russian Government

This vessel, from an outward appearance, resembles the Lake type cruising submarine, fitted with buoyant superstructure and hydroplane control for regulating the depth of submergence when running between the surface and the water bed. It was also provided with bottom wheels to enable the vessel to be navigated over the water bed. It was to have been fitted with four torpedo tubes for discharging Whitehead torpedoes, both fore and aft. She had a diving compartment in the bow, with lookout windows and a diver's door to enable a diver to be sent out ahead of the vessel for the purpose of inspecting the bottom in clearing the way, or to avoid obstructions. The vessel was to have been fitted with two rapid-fire, 3-inch rifles, arranged to fire both fore and aft for warding off the attack of small surface craft. The novel feature of this vessel, however, was the large central compartment, which was designed of sufficient size to carry thirty-six regulation navy type mines; these mines could be planted when the vessel was running on the surface or awash, or when entirely submerged on the water bed.

The above illustration shows the method of planting these mines when running in the awash condition. The mines are arranged so that they can be readily lifted and carried on a trolley over a tube extending outwardly and downwardly from each side of the central operating department. These tubes are fitted with a bottom hatch, which corresponds to the bottom door in the diving compartment. When ready to plant the mines, the central compartment is filled with compressed air, equalizing the pressure of water at the bottom of the launching tube. The bottom hatch may then be opened, and no water will come into the boat, as the trapped air will prevent it from rising up the tube. The mines are then dropped out through the tube. Salammone, or some other compound, is used to prevent the mine adjusting depth and firing mechanism from operating until the salammone becomes dissolved. This may be set to take place within a few minutes or some considerable time after the mine is placed. The safest way for planting mines from a submarine is to go down on the bottom itself so that the bottom wheels will hold the vessel to her course.

By keeping a record of the revolutions made by the bottom wheels, the exact distance from the starting point can always be determined, and any desired direction can be run by compass. It is thus possible to chart the location of each mine planted, and also to plant each mine in the location desired, which is of great importance. Owing to the desirability of carrying a large number of mines, these vessels are designed to be slow speed, of about nine knots. When planting mines submerged, the speed should not exceed one and one-half to two knots. As there is no wave motion at the bottom in ordinary weather, the mines can be carefully handled and planted. It has recently been reported by cable from London that the Germans were using vessels of substantially this type in planting mines off the English coast. The author, personally, however, has no authentic information as to whether a boat of this type has been built or not. He was informed that the Russian government contemplated building one, but since leaving there in 1910 nothing further was heard about it.

the guns of a powerful fleet, to protect its own entrances and harbors.

The submarine *Protector*, built in 1901 and 1902 at Bridgeport, Conn., was fitted with a diving compartment which corresponded to the mine-laying compartment of the 1905 design above referred to. The importance of a mine-laying submarine for the defense of the country was first officially called to the attention of the American people by a board of officers appointed by ex-President Taft (when Secretary of War), as early as January, 1903. This board of officers consisted of General Arthur Murray, late chief of Coast Artillery Corps (then Major), Captain Charles J. Bailey and Captain Charles F. Parker, of the Artillery Corps. The following is a copy of their recommendations for this type of vessel for the defense of our coast:

CONCLUSIONS AND RECOMMENDATIONS—FOR THE DEFENSE

"First and second, the board believes that this type of submarine boat is a most valuable auxiliary to the fixed-mine defense, and in cases where channels cannot be mined owing to the depth, rough water, swift tides, or width of channel, it will give the nearest approach to absolute protection now known to the board. The boat can lie for an indefinite time adjacent to the point to be defended in either cruising, awash or submerged condition, by its anchors, or on the bottom ready for instant use, and practically independent of the state of the water and in telephonic connection with the shore, or can patrol a mined or unmined channel invisible to the enemy and able to discharge its torpedoes at all times. It possesses the power of utilizing its engines in every condition except the totally submerged and can always charge its storage batteries while so doing, necessitating its return to shore only when

gasoline (petrol) must be replenished. In narrow channels the boat or boats would have a fixed position with a telephone cable buoyed or anchored at the bottom. In wide channels they would patrol or lie in mid-channel or where they could readily meet approaching vessels. Third, as a picket or scout boat, outside the mine field, or even at extreme range of gun fire, telephone communications can be sustained and information received, and instructions sent for attacking approaching vessels. Fourth, the test at Newport demonstrated the ease with which the boat can locate and pick up cables, and with minor alterations in the present model, junction boxes, etc., can be taken into the diving compartment and repaired at leisure while absolutely protected from hostile interference. The faculty possessed by the boat of maneuvering on the bottom and sending out divers leaves little or nothing to be desired in its facilities for doing this work.

"The boat shows great superiority over any existing means of attacking mine fields known to the board. First, it can be run by any field, as at present installed, with but little or no danger from the explosion of any particular mine or from gun fire, during the few seconds it exposes the sighting-hood for observations, and can attack at its pleasure the vessels in the harbor. Second and third, the board personally witnessed the ease with which cables can be grappled, raised and cut while the boat is maneuvering on the bottom; mine cables can be swept for, found and cut, or a diver can be sent out for that purpose. The crew of the boat is a skilled one, trained for its tests in every way likely to be requested by the Naval Board. It should be noted that, with one exception, no seamen are used, this exception being the man who steers and handles the boat. The crew is as follows: One navigator, who is also a diver, one chief engineer, one assistant engineer, one electrician, one machinist, one deck hand and one cook.

"The board recommends consideration of the foregoing by the General Staff. The question of the use of the Whitehead torpedoes as a part of the fixed-mine defense, fired from tubes on shore, is now receiving consideration. Where channels are

wide and water swift, this use of the Whitehead will be very limited. With boats of this type the Whitehead can, it is believed, be carried within certain effective range in all ordinary channels, and this alone will warrant the consideration asked for.

"The board recommends, in consequence of its conclusions, that five of these boats be purchased for use in submarine defense as follows:

"One for the School of Submarine Defense for experimental work, one for the eastern entrance of Long Island Sound, one for the entrance to Chesapeake Bay, one for San Francisco harbor, and one for Puget Sound.

"The necessity for this kind of defense in the four localities named needs no demonstration to those acquainted with them."

ARTHUR MURRAY,

Major, Artillery Corps, President.

The recommendations of this board were submitted to Congress and the Senate passed the bill for the purchase of the *Protector* to enable the authorities to test out the merits of this type of boat as an adjunct to our coast defense, but at this time certain politicians and financial groups were able to control the policy of the United States Government in its development of the submarine. These influences had been sufficiently strong to take out of the hands of the Navy Department or the officers connected with the Coast Artillery, who had charge of the laying of our mines and the protection of our coast from hostile invasion, the right to specify the kind of appliances they would use. Instead of leaving the question of defense of our country in the hands of the expert officers who had been trained to study the problem, Congress in this instance specified the exclusive use of a type of boat which did not possess the characteristics called for by these expert students of defense.

Strange as it may seem, the opportunity for the United States to be a leader in the development of the type of boat which Germany has proved to be of such great value, was lost by the diction of a manufacturer of gloves from an inland county. It is a sad commentary on our laws that such a state of affairs could exist, but I accidentally happened to learn that this was the case in this instance, and I fear it has been the case in many other instances where financial and political influences have been permitted to overrule the recommendation of officers of the army and navy.

The *Protector* had been built by private capital at the suggestion of the Board of Construction of the United States Navy, at that time composed of Admirals Melville, O'Neil, Bradford, Boles and Captain Sigsby. In 1901 I had been called to Washington by a telegram from the late Senator Hale, who was then chairman of the committee on naval affairs in the Senate, and was asked to submit plans and specifications for a submarine torpedo-boat. Accordingly, I submitted plans for the three types above referred to. The Board of Construction complimented me upon the plans and stated that they believed the plans of the vessels I proposed showed great superiority over any type of vessel that had been heretofore proposed, either in this country or abroad, but they stated that all appropriations made by Congress had specified the particular type of boat that must be used, and the Navy Department did not have any authority to authorize the construction of a different type, but that if I or my friends had sufficient capital to construct such a vessel, they would see that it had a fair trial upon its merits, and if it proved of value to the service they would recommend its adoption, and they did not believe that Congress would then ignore their recommendations. Consequently the *Protector* was built. Her performances and capabilities for defense of the United States were strongly endorsed by the Board of Officers which had tested her, and many of her characteristics have been copied by all European builders of submarines.

After the Senate passed the bill authorizing her purchase, the matter was referred to a sub-committee in the House. As she had been built by private capital and the life-time savings of a number of friends, as well as all my own capital, were tied up in her, I was naturally desirous to learn if the House Committee having the matter in charge was also going to recommend her purchase.

One day I called at the committee room to inquire. There was no one present in the main committee room, so I took a seat at the table. In a few moments, after sitting down, I heard a conversation in the chairman's room, adjoining the general committee room. Soon the voices took on an angry tone, and I heard one member of Congress accuse the chairman of the sub-committee having the matter in charge of intention to report unfavorably the recommendations for the purchase of the *Protector*. I recognized the voice of the gentleman who was making the accusation as that of an old retired general. He did not use polite language in accusing the chairman of the sub-committee of intent to defeat the purchase of the *Protector* in the interest of the company which had had sufficient influence to maintain a monopoly of submarine boat construction in the United States up to that time.

The chairman of this sub-committee did report unfavorably, as they planned, and, as I stated before, a manufacturer of gloves from an inland section of the country was able to defeat the recommendation for the adoption of a means of defense for this country which the best qualified officers in the United States service of both the army and the navy had recommended as of great value and superior to other defensive means known to them at that time. Recently this ex-member of Congress referred to was sentenced to imprisonment for attempt to defraud the government in other matters.

I am a great believer in the value of this type of vessel for harbor and coast defense work, and I believe that in one country vessels of this type are now engaged as mine layers in the present war. Our own government has to this day no submarine vessel equipped for the laying of mines, although the Commandant of the School of Submarine Defense repeatedly urged their adoption. I quote from the annual report of the Commandant of Submarine Defense, 1904-1905:

"As in the case of movable torpedoes, the question of the use of submarine boats as adjuncts to the fixed-mine defense of the country has been under consideration by the Board for the Revision of the Report of the Endicott Board during the past year, and the Torpedo Board has been called on for remarks on this subject.

"It is now again desired to invite special attention to the unquestionable value of submarine boats as an adjunct to fixed-mine and movable torpedoes for the defense of the particular places named in the report of the second committee; and also to the need of a boat of the LAKE type, or similar type, at the School of Submarine Defense for experimental work, as this is the only submarine boat, so far as known, that can be efficiently used in countermining electrically-controlled mines. The advisability of procuring submarine boats for the defense of the places named, it is believed, will also be seen to be unquestionable when it is considered that the cost of such a boat is about one-fortieth of that of a modern battleship; that without such boats as an adjunct to the mine and gun defenses of those places, a more expensive boat of the navy will undoubtedly be called for as a home-guard for those waters in case of war; and that with submarine boats as an adjunct to the army's defenses, it will be impossible to so defend those waters as to enable the more expensive and sea-going boats proper of the navy to cut loose from those harbors with impunity and go wherever naval strategy may demand."

(Signed) ARTHUR MURRAY,
Lieutenant-Colonel, Artillery Corps.

(To be continued)

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Some Defects in Installations of Marine Machinery and How They Were Remedied

The writer will endeavor to illustrate by means of sketches a few of the defects in marine machinery installations that have come under his observation from time to time and the means taken to remedy them, with the object of showing how a lack of running, or practical, experience on the part of the engine designer, or the parties responsible for the installation of machinery in the engine room, is often the cause of a good deal of expense in the upkeep of the engines and responsible for expensive overhauling. The writer commends, therefore, the following facts, though far from being unique, to engineers of small craft who may not often have opportunities for exchanging ideas on these points with others. Were it not for the fact that the noted firm with whom the writer is employed demanded high efficiency in the working and management of the various units at work in the construction of that big undertaking, the new breakwater and harbor works at Victoria, B. C., it might not have been within his province to discuss in this magazine some of these units with particular reference to one of the firm's steamers.

It was some years ago when, as a draftsman poring over the drawing board and plans of a destroyer's engines in the works of a well-known firm of Admiralty contractors, the writer had to concentrate his ideas upon some means by which the excessive vibration at high speed might be reduced, if not eliminated. The method adopted was the arrangement of various struts and stays between the engine cylinders and the ship's side frames, and vertical stays to the (light) deck overhead. The chief ship's draftsman, on coming around, wished to know whether certain stays from the engine were intended to support the deck, or was the deck intended through these same stays to support the engines? It certainly was not obvious, although what appeared so nice and pretty on paper was not of much use in practice. With some running experience a better appreciation might have been held as to the nature of the vibration, direction of forces and so forth.

These incidents, or accidents, outlined here from the writer's experience did not involve any nervous breakdown, nor could they be characterized as heart-breaking (although on one occasion before escaping into the engine room he was nearly asphyxiated by burning oil setting fire to the floor boards fronting the furnace), but it was sufficient to cause many an hour's overtime to be put in. We will now consider the plant under the respective headings:

BOILER

This was an ordinary tubular boiler of the marine type, with a steam dome and fired with oil fuel. It fell short, however, of local requirements as regards strength, inasmuch as the longitudinal stays were screwed into the combustion chamber, also the roof stays in the combustion

chamber and the vertical stays in the dome. All therefore had to be cut out and nutted at each end. Now all this would add considerably to the strength of the boiler, yet the boiler's efficiency was originally sacrificed for the sake of a detail.

On looking at Fig. 1 it will be seen that the blow-down valve was situated right underneath the boiler and about 10 inches from the front end. Owing to the sagging down of the boiler on the chocks, the elbow rested on the

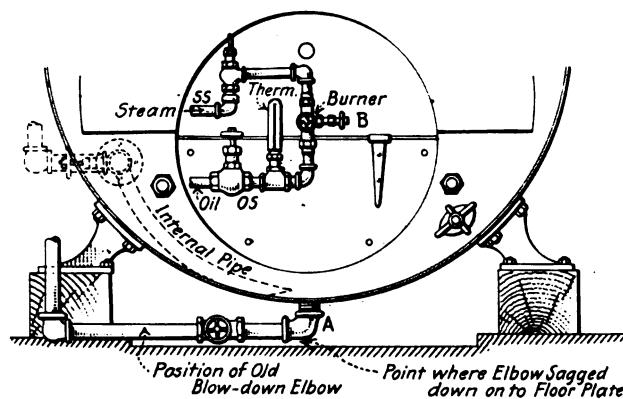


Fig. 1.—Oil-Burning Arrangement

floor plate, thereby setting up a shearing stress which caused the elbow to fracture at the point "A," causing an escape of steam which nearly scalded the engineer on watch.

I had this obsolete arrangement cut out and a flanged jointed valve fitted on to the boiler front, having an internal pipe leading from it to the lowest point inside, as shown by dotted lines.

ENGINE

The working condition of these engines was for some time a source of worry and gave considerable trouble, inasmuch as top and bottom connecting rod brasses wore

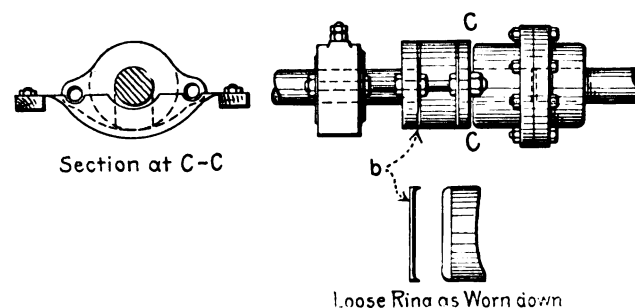


Fig. 2.—Thrust Rings and Collars

rapidly, and required adjusting every few days, while water for cooling purposes had frequently to be resorted to. The cause was eventually traced to the thrust. The first indication that there was anything wrong was the fact that the white metal rings on the ahead and astern sides of the thrust, respectively, rattled at times, sometimes revolving with the shaft, at other times remaining stationary.

Referring to the sketch of the thrust collar (Fig. 2) it

will be seen that the forward ring had worn to about one-half its original thickness, due primarily to the action of the sea water which played thereon and had caused corrosion and much eating away of the surfaces between the loose rings and thrust collar. Now this ring was a little larger in diameter than the thrust, so it had actually worn down to half its original thickness without apparent indication. Its periphery had become as if it were beaded

up in the heater (see Fig. 3) by the exhaust steam from the oil pump by means of a coil therein to a temperature of about 180 degrees F. and pumped in at a pressure of about 145 pounds per square inch. It needs but a very small jet of steam to insure proper combustion, the valve, in fact, being merely off the face, while to increase the flame the valves for steam and oil would be opened a trifle more, say one-twelfth of a turn each. Dense volumes of

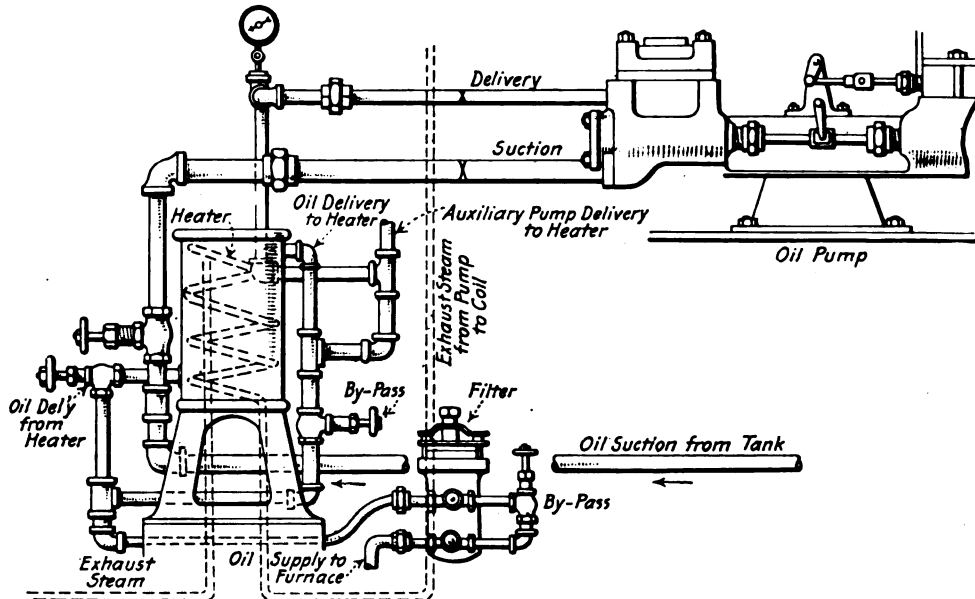


Fig. 3

over, as shown at *b*. These two very rough surfaces created a fore and aft vibration which accounted for the excessive wear and tear on the engine brasses.

The matter was remedied by having a bath of sheet iron in which the thrust might revolve; there was just space enough at "C" to allow one side of the bath to project into the space between the coupling and shoe, which would allow both sides of the bath to touch the shaft so that under ordinary working conditions the bath would

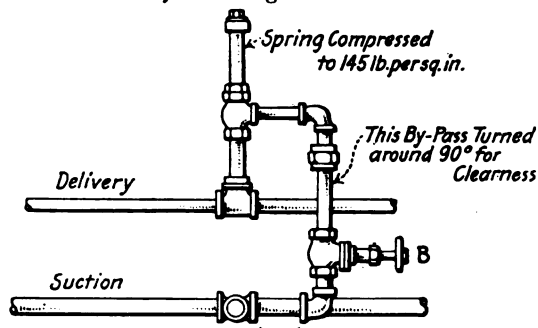


Fig. 4.—This Arrangement was Introduced at Points X—X in Delivery and Suction Pipes, Fig. 3

always have a plentiful supply of lather. After this simple arrangement everything worked satisfactorily and the bearings, instead of having to be adjusted almost every other day, now ran for weeks. A side view of the bath is shown taken through "C C."

OIL-BURNING ARRANGEMENT

The oil fuel burning system in this boiler was that known as the "Thompson system," which might be said to consist essentially in the construction of the burner. Such a system is extremely simple.

We have an oil service pipe, *O S* (see Fig. 1) and a steam pipe, *S S*, leading to the burner *B*. The oil is heated

smoke show that there is too much oil, and here is some advice that I would firmly impress on those who are inexperienced. Never open your oil valve first, but the steam jet always, otherwise the oil is apt to accumulate in the front end of the furnace and generate a gas and cause an explosion more than enough to be pleasant.

The engineer, who had to look after his fires as well as work the engines, often had to meet the difficulty of getting away from his operating levers to stop the oil pump when shutting down the fire, otherwise the oil pump would become overloaded and exceed the normal working pressure to the danger of bursting the oil service piping. To get over this difficulty and to avoid having to stop the pump, I introduced a by-pass arrangement (see Fig. 4).

Here you will observe a small spiral spring loaded valve which can be set to any desired pressure, any excess of which would leak through and pass to the suction side, so that during maneuvers the pump could be kept going at a uniform rate. Should the spring for any reason break, then the by-pass valve *B* could be closed and the oil supply continue as before.

If the brick arches in the furnace are still red hot, the burner will ignite without using a torch, but this is where one cannot be too careful. See that you do not have too much steam passing through the jet, for if any oil has been accumulating there is the danger of a back fire, and the burning oil may run on to the foot plates or be blown back out of the furnace without any warning. In case of danger and fire a control valve can be operated from the deck which cuts off the steam and oil supply, but that will not put a fire out if once it has got a hold.

The oil supply is filtered before it passes to the burner *B*, and by means of by-pass valves (see Fig. 3) the filter can be opened while under weigh for cleaning purposes, also should the steam heating coil burst the oil can pass without going through the heater. As the piping is turned

round 90 degrees in places for clearness, the course of the system may be rapidly carried out. A steam pressure of about 35 pounds per square inch should be enough to start the oil pump, and if the boiler is tight, it would take about eight hours for the steam to drop from 125 pounds to 40 pounds by the steam gage, which, of course, refers to raising steam on this particular boiler.

FEED PUMP

Fig. 5 shows our double-acting feed pump, which doubtless was a good efficient pump under normal conditions, but very much "wanting" when the observer took it in hand. "Erratic" in behavior would be a mild term to qualify its remissness. As it had to pump against 140 pounds boiler pressure, the glands necessarily had to be fairly tight, but the pump would not work steadily and could be kept going only at a moderately quick speed, the result of which would be a rapid emptying of the hot well and a consequent racing of the pump, of course to the detriment of the boiler, as with the last few strokes air would be pumped in.

Invariably this racing would occur at the most inconvenient time, such that the engineer could not perhaps get away from the operating levers. At the first opportunity he would shut off steam and next wait his opportunity to start it afresh. This unsteadiness in working was responsible for the thread wearing away in the joint of the plunger and piston rod marked *J*, so that it ultimately came adrift. Strange to say, the pump, although not working well previously, was not then thrown out of commission, as the two near side plungers were still operating, the effect being to cause the off-side piston rod and near-side valve spindle to travel quicker, thereby causing the near-side plunger to do higher duty.

On taking out the plunger I carefully calipered the same and found it had slightly worn where the packing

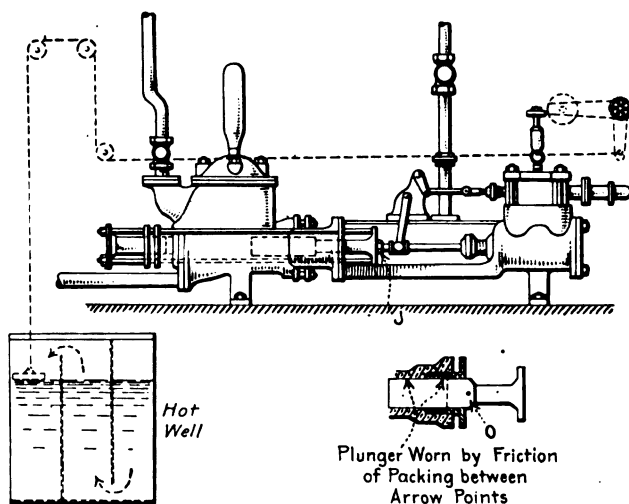


Fig. 5

Plunger Worn by Friction
of Packing between
Arrow Points

Fig. 6

rubbed, but not enough to justify condemning same. On thinking it out, however, I gathered that it took but a very slight obstruction when pumping at full load to stop the pump, and the almost imperceptible ridge on the plunger was the cause of the packing at this point getting extra compression. Also some of the packing got wedged in, as it were, between the plunger and neck ring at the bottom of the stuffing box. The fact that the plungers were cast hollow with a plug at the end was the cause of one drawing in air and discharging it through a sand hole at the point *O* (see Fig. 6).

I had the new plungers made solid and fixed up an automatic arrangement which regulated the speed of the pump

according to the quantity of water in the hot well by means of a bell crank lever having six adjusting holes, bolted on the steam regulating valve, one arm having a cord attachment passing over guide rollers to a float in the hot well, the other arm being weighted, which caused the valve to open to steam as the float rose, the float being slightly weighted to counteract the weight of lever and weight. The plaintive cry of the watchman at irregular

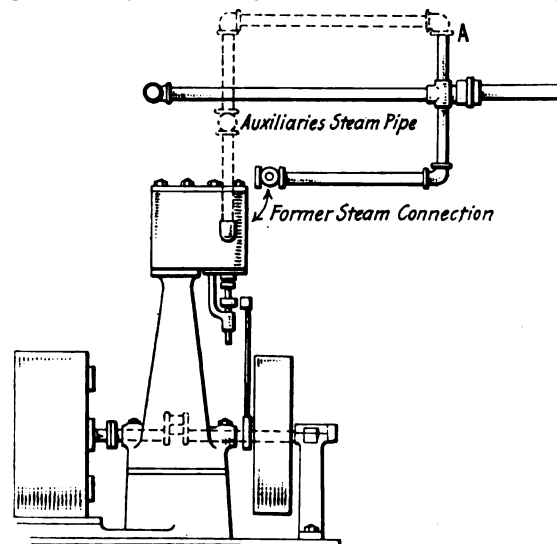


Fig. 7

intervals calling upon the gods became now a thing of the past!

DYNAMO ENGINE

One would expect having some regard to the various statements made in text-books as to the proper location of a dynamo, taking into consideration that it is essential to select some spot higher than the bottom engine roof platform, that plenty of air should circulate around the armature, that it should be in a dry place, and so forth, that at least some horse sense might be displayed in arranging steam pipe.

Just refer to Fig. 7 and you will see here an instance where a dynamo has filled the function of a veritable water trap. Note the levels of the winch piping and dynamo steam piping respectively. Here we have all the condensed water from the steam pipe gravitating back to the dynamo, the result being that as there was no drain on the engine valve chest, the piston valve rings, as well as the piston rings, broke on two occasions when getting up speed, and the electric light was put out at a critical time.

As there was a short vertical length leading to point *A*, I had a new length of piping shown in dotted lines carried to the engine cylinder. There has been no trouble since, as the steam is now dry—comparatively.

STANLEY EVANS,

Chief Engineer, Sir J. J., Ltd., No. 10.

Victoria, B. C.

The Failure of Evaporators

On some of the latest battleships the United States Navy Department departed from its standard evaporator installation in an effort to secure compactness and extreme lightness coupled with high efficiency. A well-known, reliable firm modified its standard commercial evaporator and produced an equipment that fulfilled the department's requirements.

The installation here discussed consisted of four horizontal multicore evaporators, piped for double effect opera-

tion, with ample distiller capacity, necessary pumps, heaters, traps and separators. A capacity of 28,000 gallons of potable water per twenty-four hours was guaranteed. On a capacity installation test it was found that with coils and steam manifolds free from scale the guaranteed capacity could be exceeded by 40 percent. No reliability or life test was run.

In order to secure high efficiency the designers and manufacturers used thin-coiled tubes of pure copper, provided a high steam pressure and velocity, and to secure lightness fined down the dome and shell plating and stiffeners to a minimum. Very small water and steam spaces were provided for the guaranteed output. Each unit was originally fitted with a baffle ring at the junction of the dome with the shell, a horizontal curved baffle plate in the upper part of the shell, and four vertical baffle and circulation plates parallel and close to the coil elements. The bottom blow connection and pipe was 2-inch.

The ship sailed from New York in April, having on board about 1,350 souls. The necessity of providing an ample supply of water for so large a number of men not yet trained to a seaman's economy in the use of fresh water, coupled with the fact that the vessel's machinery was new and untried, and the excessive makeup feed necessitated by numerous small leaks, made it necessary to operate the evaporators at maximum capacity on the run to Vera Cruz.

After the first four days of the voyage the output of the evaporators fell off markedly. During the three remaining days of the passage the diminution in output was progressive. When the vessel anchored the coils of the evaporators were withdrawn from the shells and it was found that the shells were filled to a depth of about eighteen inches with shale like salt, which had been cracked off the coils by blowing down, but which had not been forced out through the bottom blow, that the coils and manifolds were solidly incrustated with salt scale, and that the spaces in the spirals of the coils were filled solid with hard rock salt.

Thereafter, in order to maintain an adequate output it was necessary to give the evaporators a double blow every four hours; to fill them to the top of the upper manifold with salt water and let them soak for four hours out of every twenty-four; to give them an extra blow before starting up, and to haul the coils and scale once a week. This frequent scaling involved much labor and resulted in destructive distortion of the coils.

At the end of the third week after arrival at Vera Cruz, or within five weeks of total operation, one of the separators on the vapor line from the first effect evaporator corroded entirely through. The separator was of seamless drawn steel tubing one-half inch thick. The escaping vapor smelled strong of chlorine.

From this date internal fittings, baffles, vapor lines, fresh water lines, valves and separators were constantly failing, due to persistent, excessively active corrosion. Soon the coils began to develop pinholes and to fail at their joints; this, notwithstanding the frequent scaling and the renewal of zincs in both water and steam space.

At the end of about eight months of operation the vertical baffle and circulating plates were removed, hand holes were fitted through the lowest part of the front heads of the shells, and the pressure of the primary steam was reduced from 280 pounds to 150 pounds. The salt scale that could not be blown through the bottom blow connection was raked out through hand holes every other day. None of these changes had an appreciable effect in reducing corrosion, nor did the installation of air cocks on the separators produce more than local benefit.

Finally, having renewed coils, in addition to several renewals of fittings, dry pipes and baffles, the dome plating corroded through and the shell plating in the vapor space became greatly reduced in thickness; the I-frame stiffeners were entirely corroded away. The evaporator failed completely after about fourteen months' operation at high capacity.

About 65 to 70 percent of the coils and 50 percent of the manifolds are in the vapor space. Both water and vapor space are restricted. The evaporators were operated at high capacity. The water in the shells was constantly super-saturated with salts due to the accumulated salt scale that broke away from the coils in blowing down, but which lodged and remained in the bottom of the shells.

A chemical analysis of the deposit taken from upper manifold, made by Dr. J. P. Millwood, chemist, United States Navy, gave the following results:

	Percent
Magnesium (Mg).....	3.02
Calcium (Ca).....	1.38
Copper (Cu).....	0.89
Zinc (Zn).....	0.33
Iron (Fe).....	0.23
Alkalies (Na and K).....	
Silica (SiO ₂).....	9.5
Chlorine (Cl).....	21.37
Sulphate (SO ₄).....	8.15
Loss on drying at 105 degrees C.....	49.5
Further loss on ignition.....	4.6

"It is faintly alkaline in reaction, and treated with water only chlorides and sulphates of alkalies, magnesium and calcium are soluble.

"The sample contains water and sodium chloride chiefly, with calcium sulphate, magnesium sulphate, magnesium chloride and basic compounds of magnesium, copper, zinc and iron."

From an examination of Dr. Millwood's report it is believed that the failure of the evaporator plant is due to the generation of large quantities of hydrochloric acid and nascent chlorine

It is believed that the quantities of these active gases are due to the large coil and manifold heating surface in the vapor space, to the rate at which the evaporators had to be operated in order to supply the ship with the necessary quantity of water, and to the fact that, immediately after blowing down, a large percentage of the salt scale that cracked off the coils found lodgment in the water space of the shell (owing to the inability to blow it overboard through the bottom blow pipe), thus effectually reducing the volume of water in the evaporator and tending to super-saturate sea water with the various salts contained therein.

In this connection the following excerpts are quoted from an article on "The Corrosion of Distilling Condenser Tubes," by Arnold Philip, B. Sc., A. M. I. E. E., Assoc. R. S. M. (Admiralty Chemist), which gives the methods of determining the amount of hydrochloric acid given off, together with a discussion of its injurious effects.

He says: "Under these conditions (conditions very similar to those described in this history of evaporator failure) the magnesium chloride present is decomposed, hydrochloric acid is evolved with the steam, and a strongly alkaline incrustation and also an alkaline brine are formed. . . . From the results given above, however, it is apparent that the rate at which an evaporator is worked or, in other words, the temperature of the primary steam, caused the amount of copper in the distilled water and therefore of the hydrochloric acid formed in the evaporator, to vary. The more the evaporator is pressed, the greater the amount of hydrochloric acid formed in a

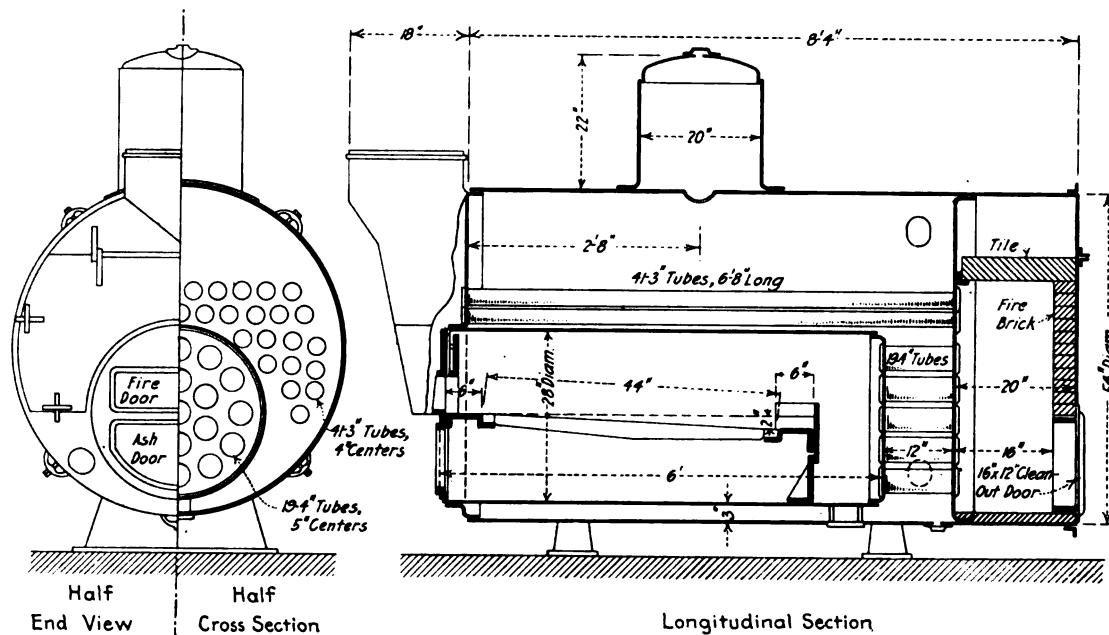
given time. There is, further, some evidence to show that the evolution of hydrochloric acid from the salts in sea water may not only be caused by the heating of the saline incrustation on the heated steam coils, but that this acid may also, but to a much smaller extent, be given off from the incrustations formed on the lower sides of the evaporator shell, and also possibly even from the brine itself, and in a given form of evaporator the formation of free hydrochloric acid is favored by the high temperature of the primary steam coils and the strong concentration of the brine. To obtain the least quantity of hydrochloric acid from a given evaporator, it is therefore necessary to avoid too great a concentration of the brine by suitable adjustment of the sea-water feed and brine cocks, and also, and most effectively, to reduce the rate of evaporation as much as possible. Both of these methods of remedying

Improved Type of Marine Boiler

The type of marine boiler shown in the illustration was designed to obtain better circulation, thereby increasing the amount of steam produced, or, in other words, the commercial horsepower, as compared with a boiler the same size but of the usual design.

The change made which was to accomplish this was to place a tube sheet in the rear end of the furnace and connect the furnace with the combustion chamber by 4-inch tubes. It was figured that this would set up a more rapid circulation than was possible by the usual method of attaching the furnace to the combustion chamber.

The test made was short and simply to determine what the boiler would do under unfavorable conditions. The shell was not insulated, the feed water very low in temperature and the coal as poor a grade of slack as could



Dry Back Marine Boiler, with Tubes Between Furnace and Combustion Chamber

the trouble are, however, faulty, for they both tend to render the evaporator inefficient. The best remedy is to only use evaporators with drowned steam coils."

From the above it appears that the experiences of the British Admiralty and of the United States Navy are very similar. It seems certain that in view of its experience the navy will revert to its former practice of installing evaporators of a drowned-tube type, of a more rugged construction, with a view to securing maximum reliability and life of operation rather than of securing the last fraction of economy. In these later evaporators the domes, coils and steam manifolds will be of composition. The first effect traps will be omitted, an auxiliary evaporator feed water heater will be installed to take care of drains from the first effect coils. By utilizing this heat from the coils to heat the feed, and by connecting the auxiliary exhaust to the first effect coils, so that the evaporators may be operated under low output conditions (in port or during overhaul periods) without using live steam, it is confidently believed the economy of the drowned-tube (or nearly drowned) will closely approximate that of the type here discussed.

W. B. TARDY,
U. S. S. *New York*. Lieutenant Commander, U. S. N.

KEEL OF THE CALIFORNIA LAID.—The keel of the 32,000-ton battleship *California* was laid at the Navy Yard, Brooklyn, N. Y., on October 14.

be imagined. It was figured that if the boiler would give the rated capacity under the most adverse conditions, it would be safe to assume that the performance under better conditions would be highly satisfactory. As the test was to determine the capacity of the boiler, or how closely the actual horsepower would agree with the designed horsepower, only such data were taken as would be of use in figuring the commercial horsepower, and these data were recorded with the greatest of care.

The boiler was set up in the shop, the stack projecting through the roof. During the test it was aimed to keep the pressure as near 100 pounds gage as possible, the safety valve being set for that pressure. The steam generated by the boiler did not perform any useful work, but was allowed to pass out through the boiler stop-valve into a pipe line placed alongside the smokestack and into the atmosphere. The feed water was carefully weighed by means of a barrel placed on a scale; from this barrel the water was allowed to run into a tank placed alongside the boiler. From this tank the feed water was picked up by an injector operated by steam from the test boiler and fed into the boiler. A thermometer was placed in this tank and the temperature of the feed water recorded every five minutes during the test.

On starting the test the height of the water in the boiler was marked by tying a string on the water gage glass; the test was stopped with the water at exactly the same

level as in starting. The condition at the start of the test was carefully noted and the test was stopped with the fire in the same condition that it was in starting, as nearly as could be judged. Natural draft was used, the stack being 40 feet high and 18 inches in diameter.

SUMMARY OF TEST

Duration of test.....1 hr. 34 m. 35 s.
Grate surface 8 5/9 square feet
Heating Surface:
Furnace crown 21 square feet
19 4-inch tubes 12 inches long.....18.62 square feet
41 3-inch tubes 6 feet 8 inches long.....199.52 square feet
Back tube sheet (effective).....3.05 square feet
Total heating surface.....242.79 square feet
Ratio H. S. ÷ G. S.....28.39
Average steam pressure by gage.....95.05 pounds
Average steam pressure, absolute.....109.75 pounds
Average temperature of feed water.....45 degrees F.
Total water fed to boiler during test.....1,845 pounds
Total water fed to boiler per hour.....1,105 pounds
Quality of steam, percent.....97
Water evaporated per hour, corrected for quality, 1,130 pounds

$$\text{Factor of evaporation, } \frac{(H - t + 32)}{966.1} = 1.212.$$

Where H = total heat of steam at 109.75 pounds absolute = 1,183.9.

t = average temperature of feed = 45 degrees F.

Water evaporated from and at 212 degrees F. = $1,130 \times 1.212$ = 1,369.56 pounds.

The evaporation of 34.5 pounds of water from and at 212 degrees F. is considered equal to one boiler horsepower by the Committee of Boiler Tests of the American Society of Mechanical Engineers. Hence the horsepower developed equals

$$\frac{1,369.56}{34.5} = 39.7.$$

The builders had rated this boiler at 30 horsepower. Hence the percentage of rated capacity actually developed was

$$\frac{39.7 \times 100}{30} = 132 \frac{1}{3} \text{ percent,}$$

or 32 1/3 percent above its rating.

As the builder in rating this boiler had used the standards of heating surface and grate surface which would ordinarily have been used for the usual type of marine boiler, and had never obtained such a high percentage above the designed rating, the excess was attributed to the only point of difference between the two types, namely, the 4-inch tubes connecting the furnace with the combustion chamber.

St. Louis, Mo.

ARTHUR C. MEYERS.

Lubrication Troubles

On a 20,000 horsepower reciprocating engine installation, fitted with forced feed, a straight mineral oil was in use. The oil gave a test viscosity of 750 at 100 degrees F., cold test 5 degrees F., and being a straight mineral oil neither mixed nor saponified with water. The oil was in use for some months, giving excellent results—when suddenly trouble broke loose in the entire system. A thorough investigation failing to reveal any extraordinary circumstances that should lead to the oil failing to function properly, a sample of the oil was removed and carefully examined in the sunlight. It was evident that water was present, but after several days there was indication of settling.

The sample was then sent to a laboratory for testing. Here it was treated with gasoline (petrol), removing all

the water from the oil and afterward reclaiming the oil. The reclaimed oil had a slightly burnt odor, with an indication of blown rapeseed. Upon mixing with water, it made the characteristic emulsion formed by mineral and blown rapeseed oils. It was quite evident that the original sample was a complete emulsion, caused by the mixing of the straight mineral oil with a compound oil.

The thrust bearings not being on the forced feed system, a compound oil made to saponify with water was in use here, and the layout of the oiling system was such that the probability of the two oils becoming mixed was so remote as to make it an impossibility. The forced feed system delivered to an enclosed crank pit. This crank pit was built so that it sloped forward, thus causing the oil to flow to a well fitted with two strainers—from which point the pumps picked it up and delivered it to the supply tank. The thrust bearing was well abaft the after end of the crank pit and about 1 1/2 feet higher. The thrust was enclosed in an oil-tight box, open only at the top, and fitted with water-cooling coils, being in itself a separate system.

Further investigation showed that only the straight mineral oil had been put into the supply tank. This eliminated everything except the hand feed oil reservoirs, and it was here that the cause was located. It so happened that just before the trouble developed the ship was running at full power for some hours. At high speeds the valve gears require a generous oil supply, and during the full power period it was necessary to refill the oil reservoirs more frequently than usual. The usual supply was exhausted and the oilers went to the storeroom for more oil. Customarily the officer of the watch supervises the issuance of all oil, but under the existing conditions his other duties were predominant and he was unable to be present.

The compound oil, for use in the thrusts, was stored in 5-gallon tins, these tins being plainly marked so as to designate the oil. This particular oil was designated by its trade name and listed for the following uses: lubrication of reciprocating main engines and auxiliaries where oiling is done by hand, through wick feed or drop oilers. From all appearances this was the oil to use, so the working tank was filled with this oil, and from then on there was a constant flow of compound oil into the crank pits. Up to the time the trouble was discovered the total was in the vicinity of 50 gallons. However, this 50 gallons, about 12 1/2 percent, resulted in a week of work and worry, as it was necessary to remove the 400 gallons in use, clean out the system and supply 400 gallons of new oil. The contaminated oil was stored for general and auxiliary use in the future, thus preventing a total loss.

The incident related above is only one of the many ways in which oils may become mixed. Oil is often received in 5-gallon tins, and there is every possibility that, in a large consignment, a few tins of strange oil may stray in, although the distributors take every precaution to prevent this. One safeguard is to obtain from the dealer, which he will gladly supply, a small sample case containing sample bottles of each oil that you have in use. Then, when supplying oil to the system, it is but a few minutes' work to remove a sample and compare its odor, color and general characteristics with the standard sample, thus removing all doubt as to the oil being O. K.

The writer has gone into considerable detail in discussing this matter, hoping to illustrate the necessity of detail in the management of oil, and especially as regards the ill effects of mixing, as illustrated in this case. It is hoped that this experience may be of value to others in the matter of saving themselves time, work, worry and money. D.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Compressive Strength of Metals

Q.—Why is the compressive strength of metals not given in the Tables of Strength? I see the tensile strength is always given but the tables have many blank spaces under the columns headed compressive strength.

S. S.

A.—The compressive strength for most metals is of less importance and is always much greater in magnitude. This, coupled with the difficulty of obtaining good determinations of it, probably accounts for its less frequent quotation.

Calculations for Thrust

Q.—(1) With a 120 horsepower oil engine running at 450 revolutions per minute and driving a boat at 20 miles per hour, what would be the approximate thrust in pounds upon the thrust collars?

(2) How is thrust calculated?

C. R. C.

A.—(1) About 1,670 pounds.

(2) Assuming that the 120 horsepower is brake horsepower and that the propeller efficiency is about 60 percent, which is reasonable for this type of propeller, there would be performed every minute $120 \times 0.6 \times 33,000 = 2,376,000$ foot pounds of effective work. This moves the boat through a distance of $20 \times 5,280 \div 60 = 1,427$ feet, so that if we have a force such that it produces 2,376,000 foot pounds of work in moving through 1,427 feet, the force is $2,376,000 \div 1,427 = 1,165$ pounds, which is the total thrust on the thrust block.

Energy and Work

Q.—Is energy the equivalent of work? Frequently I have noticed that the results of calculations of one or the other seem to be used interchangeably and I have not been able to reconcile the two. Work is force times distance, and energy (kinetic) is usually given as $\frac{1}{2} MV^2$.

A.—Energy is defined by the Encyclopedia Britannica as accumulated mechanical work. All kinds of energy are ultimately measured in terms of work. A body projected vertically upward (neglecting air resistance) will go to a height equal to

$$\frac{V^2}{2g}$$

Therefore the work done when the body is at the top of its movement is

$$\frac{W}{g} \times \frac{V^2}{2g} = \frac{MV^2}{2g} = \text{kinetic energy.}$$

Heel Pieces

Q.—What are frame butt straps or heel pieces? Where are they fitted and why are they not used or fitted at the ends of a vessel? C. L.

A.—Lloyds rules for single bottom type construction require that "when frames are butted on the keel they are

to have not less than 3-foot lengths of corresponding angle bars, fitted back to back, to cover and support the butts and be attached to the plating for at least three-fourths of the vessel's length amidship. Similar pieces of angle bar are to be fitted, if the frames are butted elsewhere." These are called heel-bars. At the extreme ends of the vessel the lower parts of the frames opposite to each other are lapped and riveted together; so no heel bars are needed, as there is no end butt with its attendant discontinuity of strength.

Coefficient of Moment of Inertia of Load Waterline

Q.—Please define the following expressions relating to a vessel's stability and give applications of same: Coefficient of moment of inertia at load waterline and coefficient of center of buoyancy above base. Please recommend some good text-book covering stability calculations, etc., of vessels.

L. T. D.

A.—Neither of these expressions are common in this country and their exact meaning is problematical. The coefficient of moment of inertia of load waterline is probably the fraction which the moment of inertia of the actual load waterline is of the moment of inertia of the surrounding rectangle. $I = clb^3$

where I = moment of inertia of load waterline

c = coefficient

l = length of load waterline

b = beam of load waterline

The coefficient of C. B. above base is probably the fraction of the draft that the C. B. is above the base.

C. B. above base = cd .

c = coefficient.

d = draft.

Stability calculations are well covered in most standard text-books on "Theoretical Naval Architecture," such as Peabody's, Biles', White's or Attwood's; this last * is the least expensive and is excellent.

* Theoretical Naval Architecture. By E. L. Attwood

Solid Steel vs. Wire Wound Guns

Q.—(1) What are the advantages and disadvantages of a solid steel and wire-wound gun of big caliber? I have read so many different opinions on this point I am anxious to know the correct facts.

(2) What are the advantages and disadvantages of a gun composed of an inner tube whose exterior diameter is decreased towards the muzzle due to a slight taper, round which is an outer tube continuous over the whole length and into which the inner tube is adjusted, after which comes the wire, etc., as compared with a gun composed of an inner tube, over which come different tubes which are shrunk on, and then the wire, etc.

C. R.

A.—(1) In the wire-wound gun the wire is wound in layers around an inner tube of steel. Each layer is wound with a different tension of the wire, and each exerts a compression on the layers which are inside of it. The result is that, when completed, the outer layers are in extension, gradually diminishing to the inner layers, which are in compression, all within the elastic limit. As wire can be made of enormous strength (as much as 200,000 pounds per square inch tensile strength), this type of gun is the strongest for the same weight of any yet developed.

No wire-wound guns are in use in the United States Navy. The British Navy uses them extensively, but they are now building built-up guns. The United States Army

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

uses wire-wound guns to a considerable extent, one reason for their use being their relative cheapness. The wire can be bought, at the present time, for about nine cents (9/4) per pound, whereas the forgings cost about thirty cents (1/3) per pound. The great disadvantage of the wire-wound gun is its insufficient longitudinal strength. This defect has never been fully overcome, and in large guns the prevention of "droop" is apt to become the dominating factor in the design.

(2) The answer to the second question is too involved and technical to be properly answered in this column. I would suggest that it be referred to some ordnance expert or publication.

Motive Power for Submerged Operation of Submarines

Q.—Will you please tell me if there is any good reason why internal combustion engines cannot be used for submerged operation of submarines, if compressed air or oxygen were carried compressed to small volume in steel flasks. I suppose there is some good reason or else the duplication of power plants would not be made. Also I should greatly appreciate it if you could, without taking up too much time or space, give a brief outline of the recent arrangement in the French submarines which permits them to use, as I understand it, their regular steam engine propelling unit when submerged.

N. O.

A.—A storage of air or oxygen in sufficient quantities to permit under water operation for any reasonable length of time requires excessive weight and space, and, further, the discharge of the products of combustion is apt to lead to the detection of the boat. The French plan, as proposed by M. de Equeville,* is to use an ordinary boiler with oil fuel and a steam engine on the surface, but when submerged the exhaust steam is led to a concentrated solution of sodium hydrate, which absorbs the steam. This absorption is chemical and there is much heat evolved, and it serves as the heating unit in a secondary "soda" boiler. This process continues till the soda solution is saturated when the boat must come to the surface. On the surface steam is again obtained from the primary boiler, the soda solution may again be concentrated by evaporation of the water which it has absorbed, and the boat is ready for another submerged run. This plan offers the advantages that there is no change of propelling motor, the same engine being used under water as on the surface, and there are no products of combustion. The machinery can be forced without difficulty and relatively high power obtained both in light and submerged condition. No electric motor is needed. On the other hand, the system requires the addition of special soda boilers and a hot water reservoir; the plant occupies so much space that the available weight cannot be fully utilized; the center of gravity of the machinery is high and requires extra ballast to be carried; the radius of action on the surface is necessarily smaller than with an explosion motor; there is likely to be a strong corrosion of the boiler due to the soda, and isolation for heat will probably cause difficulties. The soda boiler installation appears, nevertheless, more promising than other power plants so far proposed for this purpose.

* See article on "Submarines," by G. W. Hovgaard. Science Con-
spectus, 1915.

Repairs to Piston Ring

Q.—What would be the best thing to do if the high-pressure piston ring of a compound engine broke at sea?

C. H.

A.—In the case of Ramsbottom rings, if broken in only two or three pieces, the best thing to do would be to continue to use the rings. If, however, they were broken into a greater number of pieces, holes should be bored in the ends and dowel pieces inserted. If the rings are badly worn, a piece of asbestos tape could be wrapped around the bottom of the groove to hold up the ring and prevent its breaking. In the case of a deep, flat ring, a plate can be attached to the inside in the form of a patch.

Some Results from the Working of Steel Plate

Fig. 1 is a photograph of a portion of a large plate of open hearth steel from a well-known maker. The plate was 80½ inches wide, 105 inches long and 1 inch thick. It was punched with four groups of 10 holes each, arranged so that there was a group of holes near either end of each long edge, one group showing in the photograph. These holes were 1 inch in diameter and were pitched 3 inches apart. After the completion of the punching operation, a 2¼-inch flange was turned along each of the short edges, and a portion of one of these flanges is also shown



Fig. 1.—Cracked 1-Inch Plate

in the illustration. A close study of the picture will disclose the line of heating back of the turn of the flange, and will show that it did not extend very far back into the plate. The flanging was completed at just about six o'clock in the evening, and so the plate was set aside over night. In the morning, when the workmen started to resume operations on this particular job it was discovered that during the interval a crack had developed, as is shown in our view. This crack extended from the third rivet hole, which was 12 inches back from the turn of the flange, 34 inches into the plate, terminating at a point 22 inches back from the flange. The crack stood open at the plate edge about ¼ inch, and the portions of the plate were sprung so that the two edges of the crack were separated about ¼ inch in a direction perpendicular to the surface of the plate. The plate appeared and worked like good, soft material. The buttons punched from the holes stood up well when they were hammered down flat.

Several possible causes for such a behavior suggest themselves, but in the absence of information which could only be arrived at by a careful microscopic and chemical study of the material in the neighborhood of the failure, we hesitate to pronounce an opinion, preferring to leave the matter open to the discussion of those interested.—*The Locomotive of the Hartford Steam Boiler Inspection and Insurance Company.*

Marine Articles in the Engineering Press

New Steam and Motor Ships of Special Types Described— Method of Tabulating and Plotting Engineering Calculations

An Ice-Breaking Train Ferry Steamer.—The twelfth ice-breaking steamer to be built by Armstrong, Whitworth & Company, Ltd., of Walker-on-Tyne, is the *Prince Edward Island*, 285 feet long between perpendiculars, 52 feet molded depth and a mean draft of 18 feet, with a total load of 650 tons of cars and coal. The vessel is designed to transport trains across the Straits of Northumberland in Canada, a distance of some 9 miles. The chief condition called for in a ship that is to act as an ice-breaker is material strength. In this case the strength is obtained by very close and massive frames spaced only 12 inches apart throughout the length of the ship. Amidships they extend downwards from the main deck to just above the tanks, while at the ends they go completely around. Three heavy stringers are carried, all fore-and-aft, the upper one merging into a complete deck beyond the engine rooms. The plating for about 6 feet above and below the waterline is 1 inch thick and is flush throughout with an internal seam strap, over which the frames are joggled. The stem and stern frames are heavy steel castings into which the plating is rabbetted, the stern proper being 9 inches by 3 inches in section. On the waterline the angle of the plating is not vertical to the water plane, but flares at an angle of between 20 and 30 degrees, so that the pressure of the ice tends to lift the hull bodily up instead of crushing it. The section of the ship is such that the vessel will have a tendency to roll, which is of considerable advantage in an ice-breaker. The main deck forms the platform for the rails and is entirely open aft, the ship being backed into a dock and, when made fast, a draw-bridge is lowered on to the down-curve stern and butts against the end of the rail deck. A full load of cars immerses the ship about 18 inches. The arrangements for bunkering the ship are such that coal cars are run down the rails and discharge their hoppers direct down through big doors between the rails into the cross bunkers. Very comfortable and spacious passenger quarters are provided on an upper promenade deck, with dining room, lounge, smoking room, etc. The propelling machinery is exceptionally strong. The propellers are of the sectional type with blades of nickel steel of very strong section and stubby form. A good supply of spare blades is carried on board. Twin screws are provided aft, and, in addition, a propeller is fitted forward to draw away the water from under ice ahead and also to aid in berthing the vessel in a dock chocked with ice. The main engines driving the twin screws give a total of 5,000 indicated horsepower at 110 revolutions per minute with cylinders $23\frac{1}{2}$, $37\frac{1}{2}$ and 60 inches diameter by 39 inches stroke, while the forward set gives 2,000 indicated horsepower at 125 revolutions per minute with cylinders 21, $33\frac{1}{2}$ and 54 inches diameter by 36 inches stroke. Steam is supplied at 180 pounds pressure by three single-ended three-furnace boilers, fitted with Howden's forced draft. Special features developed by Armstrong, Whitworth & Co., Ltd., have been incorporated in the machinery arrangement, details of which are withheld. One device is an arrangement for keeping the water inlets to the circulating pumps clear of ice. Also arrangements are made for the application of heat to the ice surrounding the ship. Furthermore, provision is made to prevent the action of sand in wearing the stern glands when working in shallow waters. 8 illustrations. 3,600 words.—*The Engineer*, July 16.

Calculating Tables for Shipbuilding and Marine Engineering.—The article deals with the practice of representing the results of calculations with formulas in the form of tables and diagrams. It is pointed out that it is possible to introduce successively new values of one factor in a formula and present the subsequent result in the form of a curve or straight line over a system of ordinates, or even in a simple table with parallel columns. A method is also shown by which it is possible to correlate graphically three, or even more, factors or functions by setting them off on parallel bases and to connect the related points by lines. The author has found the method convenient for rapid determination of admiralty coefficients of speed, of the French midship section coefficients of speed, of diameter of propellers, of mean effective pressures of steam condensing and exhausting engines and of safety valve springs; further, have they proved themselves useful for the horsepower formula of Afonasiëff, the calculation of propeller slip, the helicoidal area of propeller blades, the indicated horsepower of steam engines or other calculations in any field of engineering. 25 illustrations. 3,000 words.—*Schiffbau*, August 25.

The Schoolship Grandduke Friedrich August.—A description is given of the third schoolship of the German Schoolship Association, of the above name in honor of its honorary president, launched January 14, 1914, and accepted and placed in service April 30. She serves, like her predecessors, solely for the training of boys for subsequent employment as sailors on board steamers and of a limited number of cooks. The ship is stated to be built in accordance with the highest requirements of the Germanic Lloyd, of the dimensions: 243 feet 4 inches by 42 feet by 24 feet 5 inches by 17 feet mean draft, with 1,695 tons gross and 747 tons net and a displacement of 2,363 tons. A Diesel engine of 400 horsepower at 165 revolutions per minute can drive the ship at 8 knots speed. The crew, including officers, numbers 271, of which 200 are boys. The ship, in the customary shape of sail ships with clipper bow and elliptical stern, is rigged as a bark with double topsails. The lower masts and principal yards are of steel and the rigging of wire or manila rope, to serve a sail area of 22,000 square feet in a double set of sails. The hull is constructed of steel, which is also employed for large parts of the decks under the wood. Six watertight bulkheads without doors divide the ship. Aft are the staterooms and office of the captain and the officers in compartments I and II. Number III is given to the engine and machinery, while IV and V are quarters for the boys, provision being made for 240 of them; the holds below are used for storing provisions and stores. A donkey boiler with bunker is also placed in compartment V. Compartment VI is devoted to quarters for petty officers above and to storerooms below. In compartment VII is a special fireproof paint room. Ballast is provided by 400 tons stone and 100 tons pig iron. Careful provision is made for fire mains, sanitary arrangements, bilge pumping, electric light and storage battery, 9 boats with capacity for 272 men, anchors, chains and wireless telegraphy. The machinery plant comprises a main engine of four-cylinder, two-cycle Diesel type, with scavenging through exhaust slots and three-stage air compressor and cooling pumps attached to the main engine. An auxiliary compressor is

driven by an independent two-cylinder, four-cycle Diesel engine with fire pump attached. Fuel is carried in three tanks of about 80 tons capacity. The propeller can be uncoupled for sailing. A small machine shop with necessary tools serves for necessary repairs. 17 illustrations. 4,100 words.—*Zeitschrift des Vereines Deutscher Ingenieure*, August 7.

The Motorship Pacific.—The great strides that have been made in the construction of motorships are shown by the record of the firm of Burmeister & Wain in Copenhagen, who had built until the beginning of this year fourteen ships, each from 6,550 tons to 9,700 tons cargo capacity, with horsepowers each from 2,000 to 4,000, and who have under construction twenty-three further ships, all with four-cycle Diesel engines, with which the firm has had remarkably fine experience. The *Pacific* had her official trial trip in December last and was immediately placed in service for South American trade. She is 366 feet by 51 feet 7 inches by 23 feet 3 inches draft, with a cargo capacity of 6,550 tons. The arrangement shows the engine room well aft, but still keeping a small cargo hold aft of it, otherwise the arrangement follows that of the average freighter. The machinery installation comprises two six-cylinder reversible four-cycle main Diesel engines of 21¼ inches bore by 28¾ inches stroke each, which can furnish collectively about 2,000 horsepower. The engines are inclosed and fitted with pressure oiling, mixing of cylinder and lubricating oil being prevented by a stuffing-box below the single-acting, open-ended cylinder. The valve gear is reversible by sliding the cam shaft and substituting a special set of cams for reversing. Each cylinder has its own fuel pump, which draws from day settling tanks of twelve-hour capacity. The auxiliaries comprise two four-cycle Diesel engines of about 200 horsepower at 225 revolutions per minute, driving each a dynamo and a compressor for air of 300 to 375 pounds pressure, stored in two reservoirs for starting purposes. Each main engine has a high stage compressor taking 300 pounds air and compressing to 880 pounds. All pumps are driven electrically, five centrifugals and two reciprocating. All winches are driven electrically, with 220 volt current, which by a rotary transformer is reduced to 110 volts for the lighting. Emergency or night lighting at 110 volts is furnished by a little two-cycle crude oil engine, which can give current also to a small high-pressure air compressor for the emergency of a total loss of all air. Heating is provided by a small oil-fired donkey boiler. The exhaust lines have double muffling, one at each engine and one in a deck house above with branches to the masts. The total weight of the machinery plant is given as 440 tons. The engine room is 40 feet long, about 26½ feet shorter than a steam engine room would be. Fuel economy in carriage is an advantage, as a round trip of three months to South America can be made with 700 tons oil instead of 1,700 tons coal with a cargo increase of 1,000 tons. The trials showed 11.41 knots at 2,033 horsepower at 153 revolutions per minute at a fuel consumption of .679 pound oil per horsepower hour. 10 illustrations. 1,700 words.—*Zeitschrift des Vereines Deutscher Ingenieure*, August 21.

The First Year at Panama.—By Winthrop L. Marvin. All told the net canal tonnage on which tolls are based on vessels traversing the Panama Canal during the twelve months ending July 31, 1915, was 4,404,364, of which by far the greatest single element was the wholly American coast-to-coast tonnage of 1,416,294. In addition to this coastwise fleet, other American cargo vessels made a certain number of foreign voyages, particularly in the trade to and from the west coast of South America, where they

were employed because of war effects on European tonnage. Throughout the Government fiscal year, ending June 30, 1915, the tolls paid at Panama by the ships of all nationalities in all trades amounted to \$4,343,383 (£892,500), while the actual cost of operation for the same period was \$4,112,550 (£844,000), so that, making no allowance for interest on the capital invested, depreciation, etc., the canal was superficially self-sustaining. The Panama Canal has entered directly into the calculations of every merchant who has built an ocean-going ship in the past three or four years on the Atlantic or Pacific coast of the United States, and the same influence has been potent on the Great Lakes. No single cause has done so much in this generation to add first-class steel steamers of an ocean type fit for auxiliary naval use to the American merchant marine. Prominent among the American steamship companies building vessels for Panama Canal trade are the American-Hawaiian Steamship Company, W. R. Grace & Co. and the Luckenbach Company. Attention is called, however, to the fact that there is not one American steamship service that goes through the canal and out upon the Pacific to South America, Australasia or the Orient. Only an occasional ship bound on a single voyage traverses the canal in international commerce. The reason why not a single American steamship has been, or is being, built for Panama-Pacific international commerce is simply a matter of wages and tolls for the operation of the ships through the canal. The steamship lines of other countries are so thoroughly subsidized by their own governments that the handicap of tolls and wages for the crew is reduced to a minimum and under the present conditions makes direct competition of American ships for this trade practically impossible. 3 illustrations. 2,200 words.—*The American Review of Reviews*, September.

The Turbine Installation on Torpedo Boats of the New Spanish Navy.—This article supplements a previous article published on May 1, 1914, in which a description was given of the first series of torpedo boats built for the new Spanish navy in which the machinery consisted of a three-shaft arrangement driven by turbines arranged three in series, the high-pressure and intermediate turbines driving respectively the starboard and port shafts, while the low-pressure turbine operated the center shaft. In the second series of torpedo boats, with which this article deals, the vessels correspond exactly in dimensions, armament and general features with those of the first series, but the machinery consists of a twin-screw arrangement, the turbines being of the Parsons impulse and reaction type constructed by the Cartagena Arsenal by the Sociedad Española de Construcción Naval. The high-pressure ahead turbine drives the port shaft and has at its forward end an impulse wheel to deal with the high-pressure steam. The low-pressure turbine drives the starboard shaft. The astern turbines are incorporated in the aft end of the high-pressure and low-pressure ahead turbines, both having both impulse and reaction blading. In both series of boats the total weight of all machinery was 75 tons and the space occupied by the machinery was the same. The diameter of the propellers on the second series of boats was 3 feet 7¼ inches and the pitch 3 feet 2½ inches. The designed speed of the boats was 26 knots with the turbines developing 3,750 horsepower. On the trials of the first boat of the first series a speed of 27.297 knots was realized. It is expected that the twin screw vessels will do as well as the triple screw boats. 21 illustrations. 1,200 words.—*Engineering*, October 1.

NATIONAL MOTOR BOAT SHOW.—The 1916 New York National Motor Boat Show will be held in the Grand Central Palace, New York City, January 29 to February 5.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements— Recent Launchings—Improved Appliances—Personal Items

In addition to Government contracts amounting to \$13,563,943 (£2,780,000) for the construction of six torpedo boat destroyers and sixteen submarines, which were placed during the past month, an unusually large number of orders for passenger and freight steamships and oil tankers have been placed with shipbuilders on both the Atlantic and Pacific coasts, and also on the Great Lakes. In addition to this, in those yards on the Atlantic coast where the facilities are especially adapted for repair work, an exceptional amount of repair work has been taken in hand, in many cases to the exclusion of new construction. As was to be expected from the present naval policy, four different navy yards, two on the Atlantic and two on the Pacific coasts, have been given contracts for a part of the new naval program.

The new merchant vessels contracted for during the month are for the most part vessels above medium size, running from 9,000 to 12,000 tons. No less than three vessels of 12,000 tons have been contracted for on the Great Lakes, and the two latest orders placed on the Atlantic coast, which were from the Standard Oil Company of New Jersey, called for vessels of about 12,000 tons.

Contracts for New Ships

Contracts for the six torpedo boat destroyers authorized by the naval appropriation of 1915 have been placed as follows: Two with the William Cramp & Sons Ship & Engine Building Company, Philadelphia; one each with the Bath Iron Works, Bath Me., and the Seattle Construction & Dry Dock Company, Seattle, Wash.; and one each with the Mare Island Navy Yard, San Francisco, Cal., and the Norfolk Navy Yard, Norfolk, Va.

Awards for the sixteen submarines authorized by the last Congress have been made as follows: Eight to the Electric Boat Company, New London, Conn.; three to the Lake Torpedo Boat Company, Bridgeport, Conn.; three on the Lake Torpedo Boat Company's designs to the California Shipbuilding Company, Long Beach, Cal., and one each to the Portsmouth Navy Yard, Portsmouth, N. H., and the Puget Sound Navy Yard, Puget Sound, Wash.

The Harlan & Hollingsworth Corporation, Wilmington, Del., has received a contract from the Standard Oil Company of New Jersey for two oil tank steamships, one of which is of about 12,000 tons.

The Seattle Construction & Dry Dock Company, Seattle, Wash., has received another contract from the New York & Cuba Mail Steamship Company (Ward Line), New York, to build a freight steamship of 5,000 tons deadweight carrying capacity.

The Fore River Shipbuilding Corporation, Quincy, Mass., has received a contract from the Texas Company, New York, to build two oil tank steamships, each 415 feet long, with a deadweight tonnage of 9,100.

The Union Iron Works, San Francisco, Cal., has received a contract from the Matson Navigating Company, San Francisco, Cal., to build a passenger steamer costing about \$1,000,000 (£205,000) to ply between San Francisco and Honolulu.

The New York Shipbuilding Company, Camden, N. J., has received a contract from the Coastwise Transportation Company, Boston, Mass., to build a 12,000-ton steamship.

The Maryland Steel Company, Sparrows Point, Md., has received a contract to build two freight steamers for the A. H. Bull Steamship Company, New York, to cost about \$800,000 (£164,000).

The American Shipbuilding Company, Cleveland, Ohio, has received a contract from the Interlake Steamship Company, Cleveland, Ohio, to build a 12,000-ton steamer.

The American Shipbuilding Company has also received a contract from the Pittsburgh Steamship Company, Cleveland, Ohio, to build a 12,000-ton freight steamer.

The Great Lakes Engineering Works, Detroit, Mich., will also build a 12,000-ton steamship for the Pittsburgh Steamship Company.

The Toledo Shipbuilding Company, Toledo, Ohio, will build four steel auxiliary schooners for the Smith Shipping Company, Inc., New York. These ships will be 261 feet long and have been designed by Cox & Stevens, of New York.

The Pusey & Jones Company, Wilmington, Del., has received a contract from the Philadelphia & Reading Railway Company, Philadelphia, Pa., to build a tugboat.

The Ellicott Machine Corporation, Baltimore, Md., has received a contract from the Pennsylvania Railroad Company, Philadelphia, Pa., to build three steel tugs.

A. C. Brown & Sons, Tottenville, Staten Island, have received an order from the Virginia Pilots Association, Norfolk, Va., for a new auxiliary schooner, designed by Cox & Stevens, New York.

The Manitowoc Shipbuilding & Dry Dock Company, Manitowoc, Wis., has received a contract for the construction for the U. S. Coast and Geodetic Survey steamer *Surveyor*, to cost \$220,000 (£45,000).

W. M. Abbott, of Milford, Del., is building a wooden steam lighter for the Johnson Lighterage Company, New York.

William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., has received a contract from the New York & Cuba Mail Steamship Company (Ward Line), New York, to build two 9,000-ton steel passenger and freight steamships. These vessels were designed by Theodore E. Ferris, 30 Church street, New York.

The Harlan & Hollingsworth Corporation, Wilmington, Del., has received a contract from the Baltimore & Carolina Steamship Company, Baltimore, Md., to build a steel hull freight steamer 250 feet long, for service between Baltimore, Georgetown, Charleston and Wilmington.

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has received a contract from the Munson Steamship Line, New York, to build a freight steamship to cost about \$625,000 (£128,000).

The Chester Shipbuilding Company, Chester, Pa., which is building a shipyard on the site of the old Roach property, is reported to have secured an order for an oil tank steamship, to be fitted with steam turbines and mechanical reduction gear.

The New York Shipbuilding Company, Camden, N. J., has received a contract from the New York Central & Hudson River Railroad Company, New York, to build four steel car floats.

The Staten Island Shipbuilding Company, Port Richmond, N. Y., will build four steel sea-going barges for the J. B. King Company, 17 State street, New York. These

barges will be equipped with oil engines furnished by the Bolinders Company, New York.

The Staten Island Shipbuilding Company has also received contracts to build one steel lighter each for the New York Central & Hudson River Railroad Company and the Pennsylvania Railroad Company.

W. & A. Fletcher Company, Hoboken, N. J., has received a contract from the New York Central & Hudson River Railroad Company to build one steel tugboat.

It is reported that the Maryland Steel Company, Sparrows Point, Md., has received a contract from the Spanish-American Iron Company, Philadelphia, Pa., to build a 450-foot freight steamship.

Alonzo Parks, Bath Me., will build a 90-foot wooden passenger steamer for the Moosehead Lake Steamboat Company.

Salvage Operations at Seattle

Interesting salvage operations were carried out last month in the center of Seattle's harbor in an effort to raise the freight and passenger steamship *Admiral Wat-*



Steamer *Admiral Watson*, Sunk in Seattle Harbor

son, which was rammed and sunk about two months ago. The salvors made careful preparations, and although several trials were made with the pumps, it was found that the submerged hull was not tight and further work by the divers has been necessary.

The accident occurred while the *Admiral Watson* was loading cargo at the municipality's Bell street wharf for the Alaska Engineering Commission, to be used in the construction of the government railroad from Knik into the interior. The vessel had about 200 tons of steel rails and lumber aboard when the steamer *Paraiso*, owned by the Long Beach Steamship Company, and under time charter to the Pacific Coast Steamship Company, of

Seattle, collided with her. A hole 18 feet in length was stove in the *Watson's* starboard side abreast the after hatch and she sank within a short time.

The contract for salving was awarded to the Seattle Construction & Dry Dock Company, of Seattle.

Shipyard Improvements

Lists and quotations on machinery and equipment for installation in the \$5,000,000 (£1,015,000) shipbuilding plant which the Continental Dry Dock & Shipbuilding Company plans to establish have been asked by the General Erecting & Improvement Company, 9 East Fortieth street, New York. This company has the entire contract for the construction of this plant, but will sublet the greater portion and will, therefore, be interested in correspondence with engineers and contractors in connection with the many contracts with it states will be embodied in the blanket contract for complete construction.

William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., will spend in the near future about \$700,000 (£143,250) for improvements and additions to its plant, consisting of rearrangement of portions of the yard, the construction of new buildings and the enlargement of some of the shipways.

The New York Shipbuilding Company, Camden, N. J., has been granted a permit for a one-story frame and iron storage building, 83 feet by 89 feet.

The Lake Torpedo Boat Company, Bridgeport, Conn., has taken out a permit for a building 90 by 240 feet, with an ell 60 by 60 feet.

The Lauritzen Transportation Company, Antioch, Cal., has purchased the Jarvis Shipyards, Antioch.

The Newburg Shipbuilding & Manufacturing Company, Inc., has been organized at Newburg, N. Y., with a capital stock of \$150,000 (£30,800). The incorporators are Benjamin B. Odell, Jr., Frank N. Bain and A. L. J. Miller, all of Newburg.

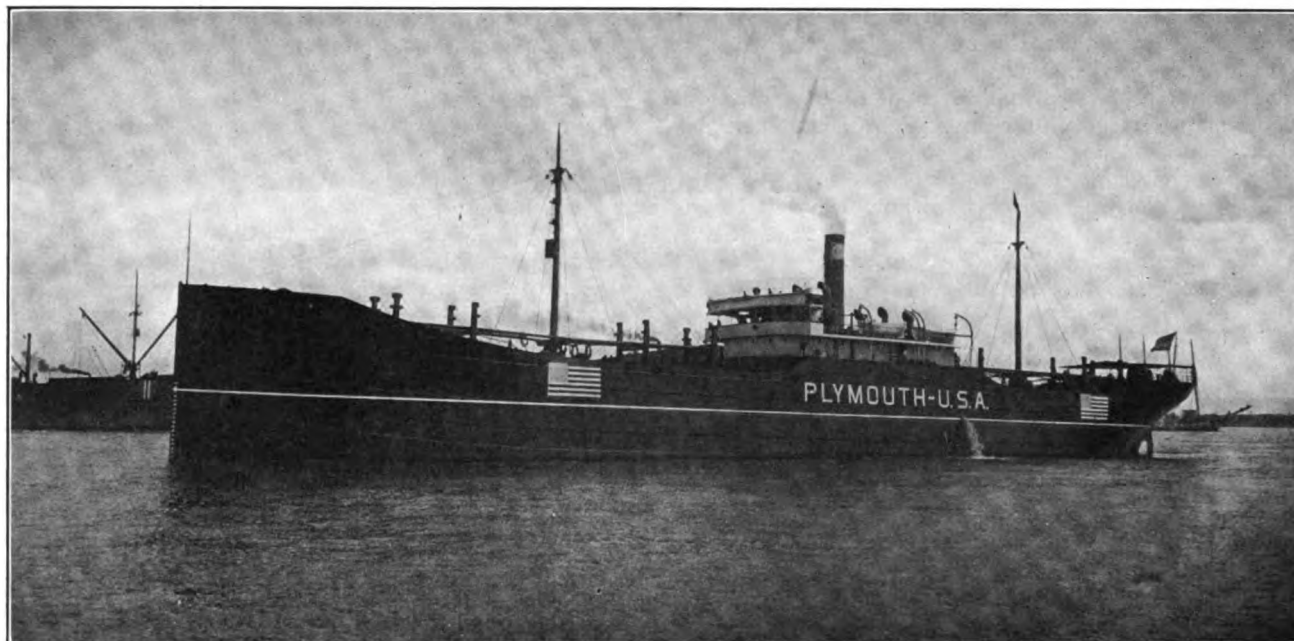
The Robins Dry Dock & Repair Company, Erie Basin, Brooklyn, N. Y., will enlarge its shipbuilding plant at a cost to exceed \$100,000 (£20,500), with the intention of being able to repair vessels of all sizes from a small tug to the largest transatlantic liner. This company is now converting the steamers *Kroonland* and *Finland*, of the Red Star Line, into oil burners.

New Steamship Company Enters the South Atlantic Trade

American and English shipping interests are forming plans to enter the South Atlantic steamship field on an extensive scale. To this end the American Merchant Marine Company has been organized under the laws of Delaware with a capital stock of \$3,000,000 (£615,000). The general management of the enterprise will be under the supervision of Bowring & Co., 17 Battery Place, New York.

The new service, according to reports, will first enter the coastwise trade and will be known as the Southern Cross Line. Later it is the intention of the management to extend operations to the Gulf ports and also to South American ports.

It is planned shortly to place contracts for seven freight and passenger steamers.



S. S. Plymouth, 335 Feet Long, 55 Feet Beam and 34 Feet 6 Inches Depth, Built by the New York Shipbuilding Company at Camden, N. J., for the Coastwise Transportation Company, Boston, Mass.

New Steamship Lines

The Edenton & Chowan Steamboat Company, with a capital of \$50,000 (£10,250), has been organized at Elizabeth City, N. C., by A. S. Foreman, A. S. Daniels and R. E. Black.

The Red River Navigation Company, capital \$50,000 (£10,250), has been organized at Shreveport, La., by W. K. Henderson, O. A. Wright, J. C. Abel and F. D. Lee, to operate a line of barges on the Red River.

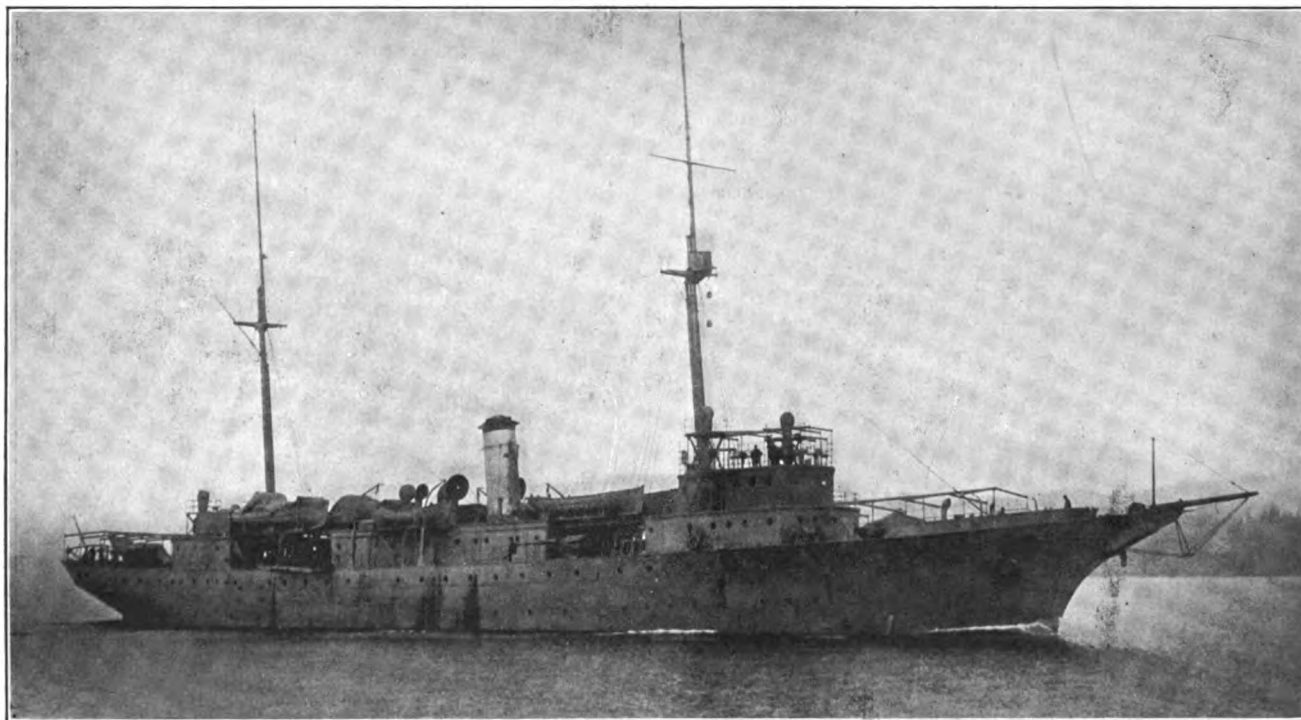
The Occidental Steamship Corporation has been organized in the State of New York, with a capital stock of

\$1,000,000 (£205,000). Winslow, Keenan & Budd, New York, are attorneys for the corporation.

Witherbee, Sherman & Co., Port Henry, N. Y., who operate iron ore companies, are planning, it is reported, to make shipments by water when the new Champlain Barge Canal is completed. This, if true, will render necessary the construction of a large number of steel barges.

Marine Terminal Projects

The Federal Government is planning the construction of an iron and concrete dock at Southport, N. C.



Submarine Tender *Bushnell*, of 3,580 Tons Mean Trial Displacement, Recently Completed by the Seattle Construction & Dry Dock Company, Seattle, Wash., for the United States Navy

The Healy-Tibbitts Construction Company, San Francisco, Cal., will build a shed on Pier 35, San Francisco, at a cost of \$74,722 (£15,300).

It is reported that Mayor Preston, of Baltimore, favors further improvements on the water front in Baltimore, between Fort McHenry and Ferry Bay, including the construction of eight piers.

The Riverside Contracting Company, New York, has received a contract for extending Pier 22, North River, New York, at a cost of \$22,366 (£4,600).

The Torpedo Damage to the Oil Tanker *Gulflight*

While on a voyage with a cargo of benzine destined for Rouen, the oil tank steamer *Gulflight* was torpedoed by a German submarine near the Scilly Islands on May 1. It so happened that the damage was almost entirely confined to the dry cargo space, and, after being partly submerged for some time, the vessel proceeded to Rouen, delivered the cargo there, and subsequently sailed for the Tyne for repairs.

It may be recalled that the *Gulflight* forms one of the large fleet of the Gulf Refining Company, of New York, and was built in 1914 by the New York Shipbuilding Company, of Camden, N. J. The vessel is a sister ship to the *Gulfcoast*, *Gulfoil* and *Gulfstream*, built at the same yard

for the same owners, and is constructed on the Isherwood system of longitudinal framing. She is 383 feet in length, 51.2 feet in breadth and 30 feet depth. The gross tonnage is 4,591 and the net tonnage 3,202.

Figs. 2 and 3 show the vessel afloat, and Fig. 1 as under repair in the No. 4 dock of Messrs. Smith's Dock Company, Ltd., at North Shields. These illustrations afford an excellent idea of the extent and nature of the damage, which consisted of a large hole on the starboard side, several small holes on the port side, and the damage to the cargo hold forward cofferdam, forward pump room and forward peak. The corrugations show the strength of the longitudinals.

The renewals consisted of 25 new shell plates, 10 removed, straightened and replaced, and all of the transverses and longitudinal frames on the starboard side, and some of those on the port side were renewed, and the center keels renewed in the way of the damage. The deck and beams in the fore hold were entirely renewed, the fore peak and fore cofferdam bulkheads were partly renewed, and the whole of the pump room was also renewed.

The tanks throughout the ship were water-tested and the whole of the piping installation was overhauled and repaired. Although the *Gulflight* was only undocked at North Shields on July 4, the repairs were fully completed and the vessel sailed on August 22 for the Humber and thence for Port Arthur (Texas).

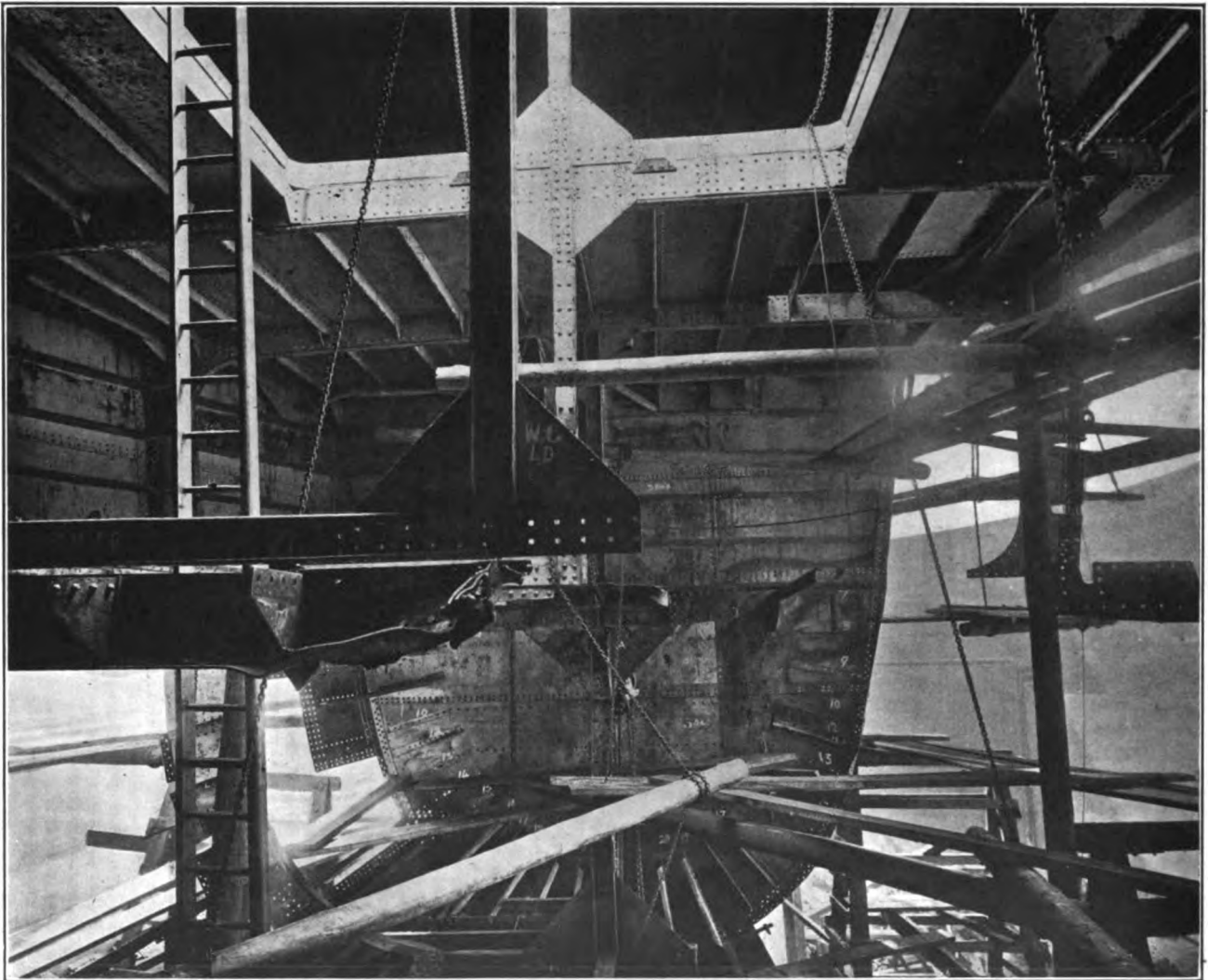


Fig. 1.—View of Forward Hold of *Gulflight* with Damaged Parts Cut Away Previous to Re-construction

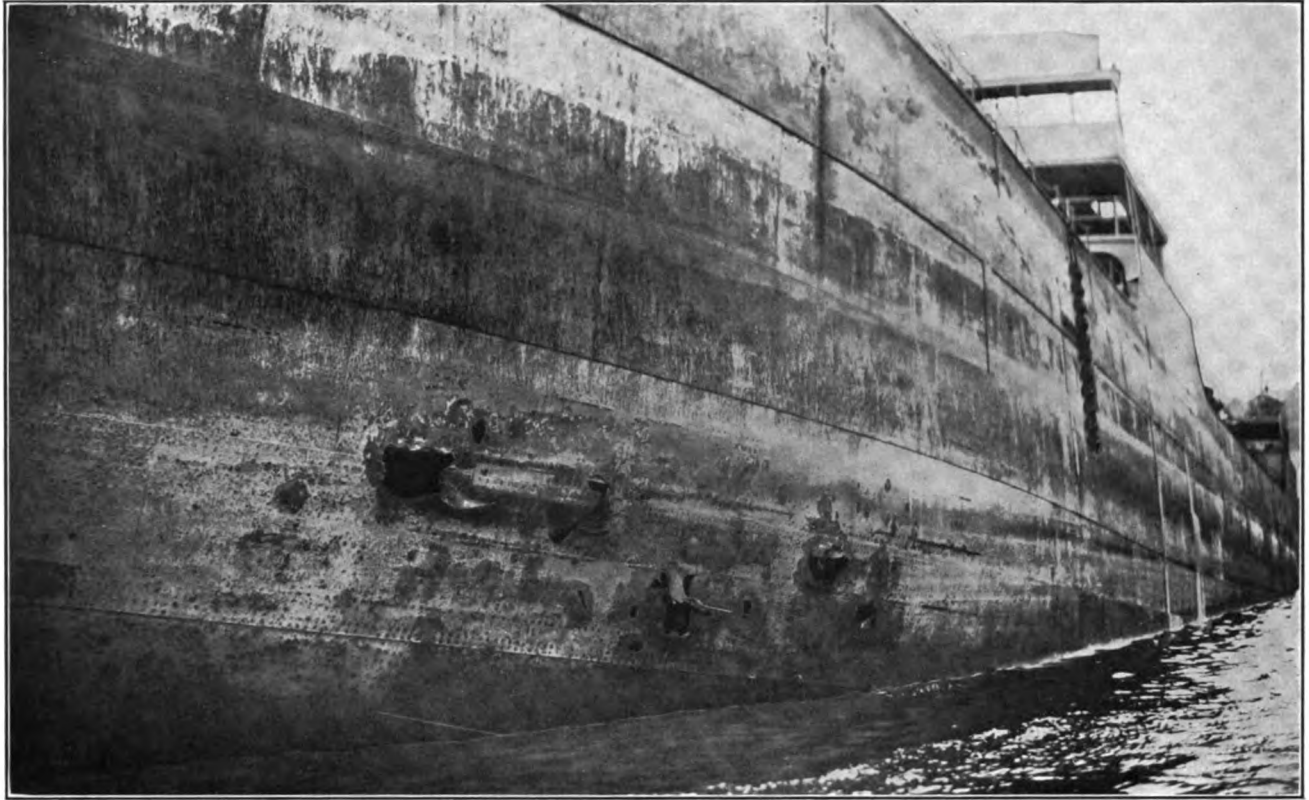


Fig. 2.—Port Side, Showing Holes Made by Force of Explosion from Starboard Side

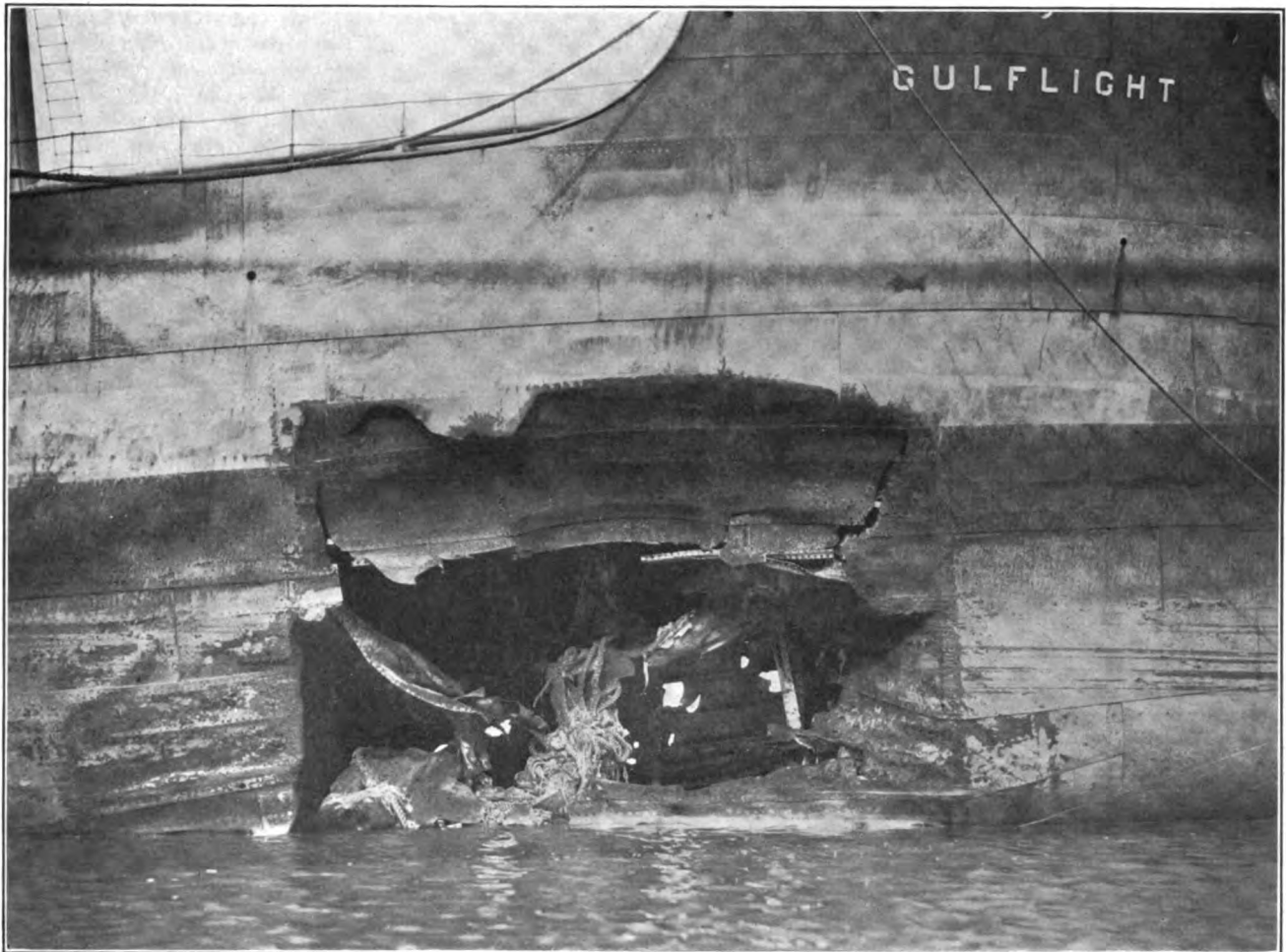


Fig. 3.—Damage to Starboard Side. Corrugations in Plating Show How Longitudinal Framing Resisted Explosive Force of Torpedo

ENGINEERING SPECIALTIES

60 Horsepower Nilseco Diesel Engine

The New London Ship & Engine Company, Groton, Conn., has placed on the market a 60 horsepower Diesel engine of the vertical, single-acting, four-cycle type. Reversing is obtained by means of a heavy duty type of mechanical reverse gear, with friction disks for the ahead motion and spur gears and a band clutch for the astern motion. The thrust is of the roller bearing type. The engine has four working cylinders 7 inches diameter and 9½ inches stroke, and develops 60 horsepower at 450 revolutions per minute. At the after end of the engine there is an air compressor of the two-stage tandem type for supplying air for injecting the fuel and for starting purposes. Provision is made for regulating the pressure carried on the spray air by means of a throttle on the first-stage suction. The weight of the engine complete with flywheel, clutch and thrust bearing is about 8,000 pounds.

The bedplate is in one piece, of cast iron, and is enclosed to catch all oil draining from the bearings. Flanges are provided for bolting to the foundation and for carrying the housing. Cross girders are provided for the main bearings for the crankshaft. The main bearings have cast iron shells lined with white metal, with semi-circular lower brasses, so that they may be rolled out after removing the weight of the crankshaft. The bedplate is extended right aft to take the reverse clutch and thrust bearing.

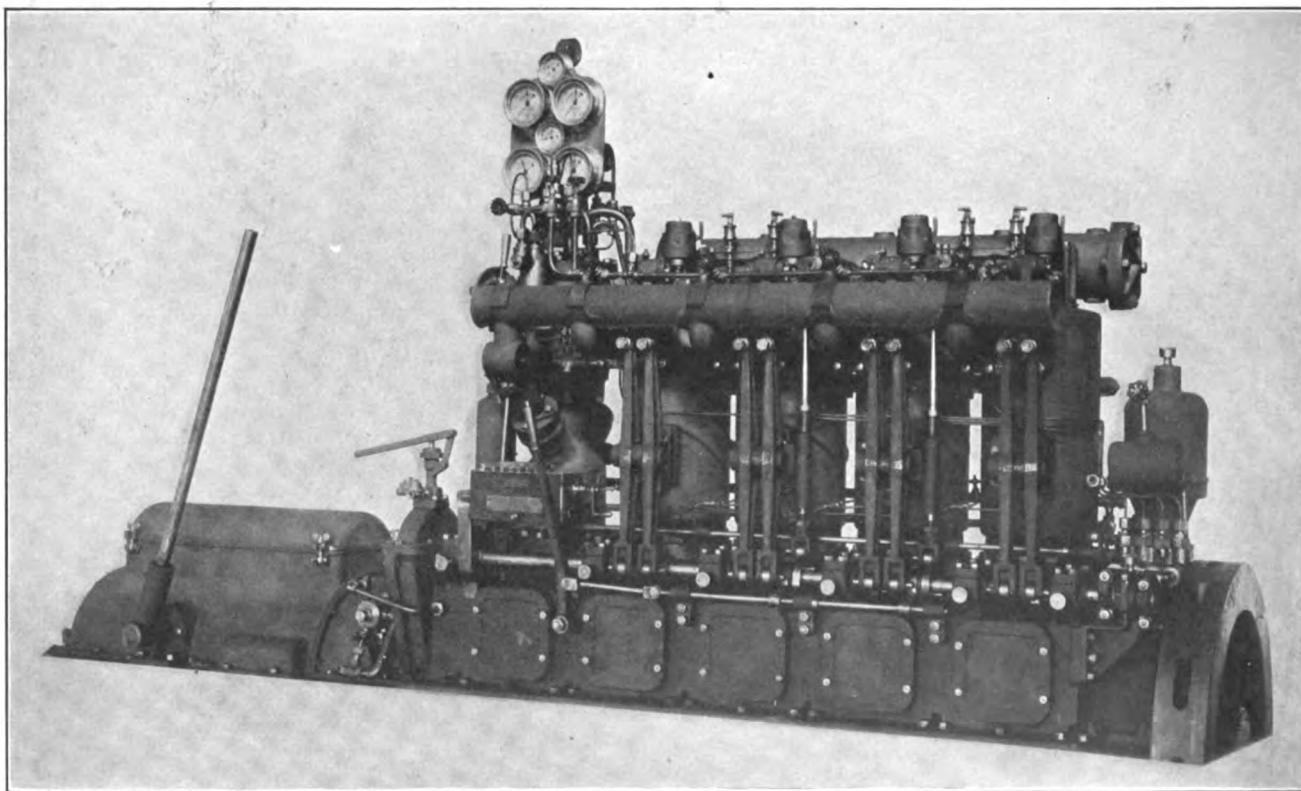
The housing is in one piece of cast iron of rigid design and bolted directly to the bedplate. Large openings with readily removable covers are provided on both sides for access to the crankpit. To the top of the housing are bolted the working and compressor cylinders and the camshaft bearings.

The crankshaft is of forged steel in one piece. The connecting rods are of forged steel with solid wristpin ends fitted with phosphor bronze bushings and tee head crank ends for bolting to the crankpin boxes. The crankpin boxes are of cast steel lined with white metal. The wristpins are steel forgings, hardened and ground and secured in the the pistons.

The working cylinders are of cast iron with water-jacketed barrels and heads. The cylinder heads are cast integral with the barrel and contain all the valves. The pistons are of cast iron of the trunk type and fitted with cast iron snap rings to retain the compression. Each cylinder has an inlet valve and a relief valve on the front of the engine, a spray valve on top and an exhaust valve on the back. The inlet valve is of forged steel and is carried in a separate cage. The exhaust valve has a steel stem with a cast iron head of special design to withstand the action of the hot exhaust gases. The spray valve has a steel needle with atomizer and cage of special design.

The two camshafts, carried in white metal-lined cast iron bearings on the top of the housing, are driven from the crankshaft by means of spur gears on the after end of the engine. The camshaft on the back of the engine operates the exhaust valves by means of rocker levers. The camshaft on the front of the engine operates the inlet valves by means of rocker levers and the spray valves by rocker and bell crank levers. Two of the cylinders are fitted with air starting valves operated from the front camshaft. The operating gear of these valves is so arranged that when they are in operation the spray valves on these cylinders are cut out, and when the spray valves are operating the starting valves are cut out.

The first and second stage air compressor cylinders are in one piece, of cast iron, water-jacketed and with a separate water-jacketed cast iron second stage head. Both the first and second stage valves are of the auto-



60 Horsepower Nilseco Diesel Engine with Mechanical Reverse Gear

matic spring-controlled type with cone seats. The air cooler, placed on top of the compressor, has separate passages for first and second stage air and has sufficient surface to thoroughly cool the air after each stage of the compression. A spray air flask is secured back of the compressor and is connected into the line between the compressor and the spray valves.

Forced lubrication is used for the principal bearings, the oil being supplied under pressure to the main bearings and thence passing through holes drilled in the crankshaft to the crankpins and through the connecting rods to the wristpins. All surplus oil drains back to the crankpit, is filtered and used over again. The crank case is oiltight to prevent leakage of oil outside. The cylinders are supplied from a positive feed mechanical oiler. Camshaft and other bearings are fitted with grease cups. A few, which are subject to very little motion, are oiled by hand.

The flywheel is bolted to a flange on the forward end of the shaft. There is a flange at the after end of the shaft for bolting to the reverse clutch shaft.

An emergency governor driven from the back camshaft is located at the forward end of the engine and controls the engine speed by holding open the fuel pump suction valves.

The fuel system consists of a pump located at the forward end of the engine and driven from the front camshaft extended, with a separate plunger for each cylinder. Fuel is supplied to this pump from a gravity tank, which is divided into two parts with a filter between to prevent foreign matter reaching the fuel pumps. The discharge from each individual fuel pump leads to its respective spray valve. The speed of the engine is controlled by the amount of fuel supplied to the cylinders, which in turn is controlled by the timing of the individual pump suction valves. The cooling water pump is of the rotary type.

The suction header, forming the inlet muffler, runs along the front of the engine and all working cylinders and the compressor cylinder take air through it. The exhaust header, secured to the tops of the cylinders, is of cast iron and water-jacketed.

The engine is started by means of compressed air supplied to the two middle cylinders. The spray and air starting cams for each of these cylinders are in one piece and the cams for both cylinders are under the control of a common lever. With this lever in one position the air starting valves are in operation and in the other the spray valves are in operation. When starting the engine the starting valves are thrown in, the engine jacked over until one of the cylinders is ready for starting air, the starting air is then turned on and the engine responds at once. As soon as ignition is obtained in the end cylinders, the air starting lever is thrown over, cutting out the starting valves and throwing in the fuel valves and the engine is under normal operation on fuel.

[Weston Portable Electrodynamometer Instruments

Problems hitherto considered impossible of solution have been solved, it is claimed, in the designing of the various electrodynamometer instruments which have been placed on the market by the Weston Electrical Instrument Company, Newark, N. J. This line of instruments includes portable single and polyphase watt and volt meters for both alternating and direct current circuits, all of which are meters of precision. The instruments are guaranteed by the manufacturers to have an accuracy of one-half of one percent full scale value on either alternating or direct current circuits of any frequency up to 133 cycles per second and any wave form.

They can be used on circuits of any commercial frequency even as high as 500 cycles per second with very slight error, due to phase displacement. Double ranges are provided for both current and voltage circuits. All current ranges can be used for 100 percent overload indefinitely, it is claimed, without introducing error. The movable systems of the instruments have an extremely low moment of inertia, and are very effectively damped. Indications are independent of room temperature or the heating effect



Fig. 1



Fig. 2



Fig. 3



Fig. 4

of current passing through the coils and the instruments are shielded from external magnetic influences.

Fig. 1 shows a single-phase and direct current portable electro-dynamometer wattmeter, Model 310. The scales, which are $5\frac{1}{4}$ inches long, are uniform throughout their entire length. Each scale is hand calibrated and is provided with a mirror over which the knife-edge pointer travels. The pointers are equipped with a simple zero setting device. Special wattmeters can be provided for very low power factors, such as core losses in transformers, giving full scale deflection for 20 percent power factor—that is, the scale value in watts is 20 percent of the volt amperes applied. Fig. 2 is a portable polyphase wattmeter, Model 329. The scales of this meter are also uniform throughout. Figs. 3 and 4 show a portable voltmeter, Model No. 341, and portable ammeter, Model 370, respectively. Both are designed for use on direct current and alternating current. Owing to the principle of operation, these instruments cannot be made with scales that are uniform throughout their entire length, but the upper four-fifths portion of the scale is remarkably legible and uniform. These instruments are all inclosed in mahogany boxes of convenient size.

The "Simplat" Valve—Its Construction and Operation

The Chicago Pneumatic Tool Company, Chicago, Ill., has placed on the market a new design of flat plate air compressor valve known as the "Simplat" valve, for which many advantages are claimed. Its chief advantages are that it is simple; that its plates are independent in action; that each plate has its individual springs; that the tension of the spring on the inlet and discharge valves differs according to the density of the air handled; and,

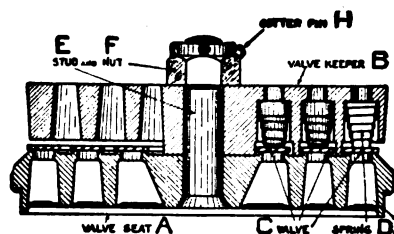


Fig. 1.—Discharge Valve

lastly, that it is applicable to all positions and conditions.

Fig. 1 shows a discharge valve. The valve seat *A*, cast from a special composition, has circular ports. It is machined so that the raised portion of the seat, or the points on which the plates rest, forming the joint, is very narrow, thus reducing the unbalanced area to a minimum. The keeper *B* is of the same material, and is provided with suitable ports for the free passage of air through it. It also furnishes the guides for the valve plates, and affords as well satisfactory pockets for the valve springs. The valves *C* are concentric steel plates of uniform section, with a separate and independent plate over each port. Each

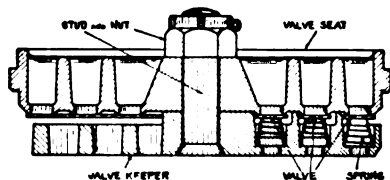


Fig. 2.—Inlet Valve

plate is independently governed by its own springs, hence the action or opening of each valve is entirely independent of the other. Should one of the plates open, the one next to it does not necessarily need to move, unless the speed conditions should demand it. The springs *D* are of the volute type. The parts making up a complete valve are assembled and held together by the nickel steel stud *E* and castle nut *F*, and when this nut is securely tightened in place it is firmly held so by cotter pin *H*.

Fig. 2 shows the inlet valve, the construction of which is very similar to that of the discharge valve. It differs only in the following respects: The valve stud enters through the keeper instead of through the seat, as does the discharge; the keeper is thinner, and the springs are of lighter tension. On account of the difference in the thickness of these valves, they cannot be reversed; that is, the inlet cannot be put in where the discharge should be, nor the discharge where the inlet belongs—a precautionary measure deemed to be highly necessary. The spring tension on the inlet valves is made very light, so as to get the full benefit of the varied opening of the different plates when the piston speed is changed. This illustrates the true meaning of the varied opening.

PERSONAL MENTION

Operating Engineers

W. R. Plant has been appointed assistant engineer of the tug *Sipsey*, New Orleans, La.

E. H. Payne, of New Orleans, La., has been appointed first assistant engineer of the tug *J. W. Morse*.

Daniel Kinsella, of New Orleans, La., has been appointed chief engineer of the tug *Underwriter*.

Eugene Bolander, of New Orleans, La., has been appointed first assistant engineer of the steamer *Parmco*.

James Park, of New Orleans, La., has been appointed first assistant engineer of the steam schooner *Mary Olsen*.

Paul Craver, of Rondout, N. Y., has been appointed chief engineer of the steamer *Marguerite*, stationed at Albany, N. Y.

Henry Gates has been appointed night engineer of the United States Government tug *General Totten*, at North Troy, N. Y.

Samuel J. Ryan, of Glens Falls, N. Y., has been appointed chief engineer of the United States Government tug *Colonel Thayer*.

Ed. Miller, of New Orleans, La., has been appointed second assistant engineer of the steamship *J. D. Archbold*, of the Standard Oil Company.

"Milwaukee" Bill Ryan has been appointed chief engineer of the *William H. Kinch*, of the Great Lakes Dredge & Dock Company, at Albany, N. Y.

Melvin Leap has resigned as chief engineer of the *Val P. Collins* to accept the position as chief repair man for the boats of the Combined Coal Company at Cincinnati, Ohio.

Henry Stammell, formerly chief engineer of the steamer *William H. Kinch*, has been appointed chief engineer of the tug *Lydia* for the Miller Dredging Company, Albany, N. Y.

A. Erickson, of New Orleans, La., formerly of the tug *Underwriter*, has been appointed second assistant engineer of the steamer *Chalmette*, of the Southern Pacific Company.

Sam Wheatland has been appointed acting chief engineer of the large tug *Welcome*, which has been brought from Buffalo, N. Y., to Albany, N. Y., by the Great Lakes Dredge & Dock Company.

Earle Byron has been appointed chief engineer of the passenger steamer *Ohio*, with W. H. Webber as first assistant engineer. The *Ohio* is plying between Cincinnati, Ohio, and Memphis, Tenn.

William Spencer, chief engineer of the steamer *G. I. S. Quackenbush*, of the Troy & Albany excursion line, has accepted a position on the steamer *Mohawk*, of the Manhattan Navigation Company, New York.

A. J. McMillan, formerly of the steamship *Coppername*, of the Fruit Steamship Company, Ltd., has accepted the position of first assistant engineer of the steamer *New Orleans*, of the Merchants & Miners Transportation Company.

E. J. Taylor, of Cincinnati, Ohio, has been appointed chief engineer of the river passenger steamer *Kentucky*, with Richard Simms as first assistant engineer. The

Kentucky runs between Cincinnati, Ohio, and Madison, Ind.

Carlisle Jenkins, of Cincinnati, Ohio, formerly chief engineer of the river steamer *Val P. Collins*, has been appointed chief engineer of the *Catharine Davis*, with Phillip Klipp as first assistant engineer. The *Catharine Davis* is engaged in towing coal for the Island Creek Fuel Company from Huntington, W. Va.

Naval Architects, Consulting Engineers, Draftsmen and Shipyard and Steamship Officials

Peter Doig, formerly connected with the firm of Harland & Wolff, Belfast, is now chief draftsman of the Shanghai Dock & Engineering Company, Shanghai, China.

William M. Kennedy, formerly quartermaster ship fitter at the League Island Navy Yard, Philadelphia, Pa., has been appointed foreman of hull construction at the works of the Ellicott Machine Corporation, Baltimore, Md.

W. A. Fairburn, who was connected with shipbuilding several years ago in the drafting room of the Bath Iron Works, and who later had to do with the designing and building of the steamships *Dakota* and *Minnesota* at the yard of the Eastern Shipbuilding Company, Groton, Conn., has been made president of the Diamond Match Company.

George Owen, naval architect of Newton, Mass., and a graduate of the Massachusetts Institute of Technology, has been appointed to fill the vacancy in the faculty of the department of naval architecture of the Massachusetts Institute of Technology, Boston, Mass., caused by the resignation of H. A. Everett, associate professor of naval architecture at the Institute.

Foster Milliken, formerly president of Milliken Bros., Inc., manufacturers of structural steel and iron, has been elected president of the McNab & Harlin Manufacturing Company, New York, a firm which has been engaged during the past sixty years in the manufacture of brass, iron and steel valves, cocks and fittings for steam, water and gas. The main offices of the company are at 55 John street, New York, and its works at Paterson, N. J.

OBITUARY

Sir Thomas Benjamin Bowring, director of T. C. Bowring & Co., ship owners of Liverpool and London, died on October 18 at his home in London, in his sixty-ninth year. Sir Thomas represented his firm as resident partner in New York from 1870 to 1891.

Captain John J. Knapp, U. S. N., commandant of the Philadelphia Navy Yard, died at the Navy Hospital at Philadelphia on September 28 from apoplexy. Captain Knapp was fifty-eight years old.

Captain William F. Evans, senior captain of the Mallory and Clyde Steamship Lines, died recently in San Juan, Porto Rico, aged sixty. At the time of his death Captain Evans was in command of the steamship *Brazos*. He had been employed in the passenger service between Galveston and New York for over thirty years.

John Lloyd, president of the John Lloyd Company, New York, died on October 5 at his home in Brooklyn, aged eighty. During the Civil War, Mr. Lloyd served in the United States Navy as an assistant engineer, and resigned in 1867 with the rank of first assistant engineer.

Merritt David Lawrence, vice-president and treasurer of

the firm of Downey & Lawrence, marine railway engineers, Brooklyn, N. Y., died recently at his home in Brooklyn, aged seventy-six.

John E. Dealy, connected with the Robins Dry Dock Company, Brooklyn, N. Y., and a prominent member of the New York Maritime Exchange, died recently at his home in Brooklyn, aged forty-one years.

Paul Gottheil, for many years a member of the shipping firm of Funch, Edye & Co., New York, died at his home in Lawrence, Long Island, on September 22, aged fifty-nine. The firm of which Mr. Gottheil was a member is said to represent more regular steamship lines than any other single firm in North America, their principal agency being that for the Holland-America Line. Mr. Gottheil was also president of the United States Shipping Company, formed in 1896.

Programme of Naval Architects' Meeting

A partial list of the papers to be read at the twenty-third annual meeting of the Society of Naval Architects and Marine Engineers, in New York, on November 18 and 19, is as follows:

"Aerodynamical Experiments upon a Yacht's Mainsail." By Professor H. A. Everett.

"Inland Navigation and Barge Construction vs. Floating Bridges." By J. H. Bernhard.

"The Variation in Frictional Resistance of Ships with Condition of Wetted Surface." By Naval Constructor Wm. McEntee, U. S. N.

"The Determination of the Resistance of Ships." By E. H. Rigg.

"Results of Model Tank Experiments to Determine the Action of a Ship Brake." By Captain Wm. Strother Smith, U. S. N.

"Some Comparisons Relating to Electric Propulsion of a Battleship." By W. L. R. Emmet.

"Interior Decoration of Vessels." By Harry B. Etter.

"Data on Hog and Sag of Merchant Vessels." By T. M. Cornbrooks.

"Period of Vibration of Steam Vessels." By Wm. Gatewood.

"The Application of Small Steam Turbines for Auxiliary Purposes on Board Ship." By W. J. A. London and F. D. Herbert.

"The Maintenance of the Fleet." By Captain A. P. Niblack, U. S. N.

"The Submarine of To-day and To-morrow." By L. Y. Spear.

"Superheated Steam in Marine Practice." By H. B. Oatley.

The meetings will be held in Assembly Room No. 1, Engineering Societies Building, 29 West Thirty-ninth street, beginning at 10 A. M. each day of the meeting.

The Council of the Society will meet in the Engineering Societies Building at 3 P. M. on November 17 and the annual banquet will be held at the Waldorf-Astoria Hotel on Friday evening, November 19.

CORRECTION.—The work of fully equipping the freight and passenger steamer *City of St. Joseph*, of the Graham & Morton Transportation Company, Chicago, Ill., with lifeboats, life rafts and davits supplied by the Welin Marine Equipment Company, Long Island City, N. Y., which was described on page 372 of our August issue, was done by the Manitowoc Shipbuilding & Dry Dock Company, of Manitowoc, Wis.

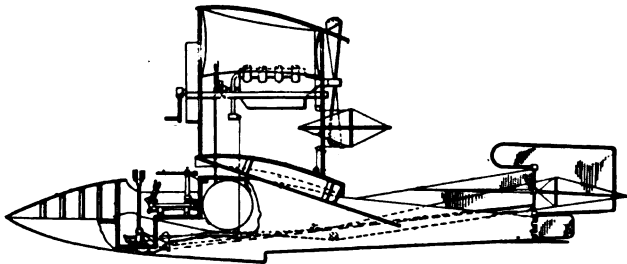
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,142,754. FLYING BOAT. GLENN H. CURTISS, OF HAMMONDSPORT, N. Y.

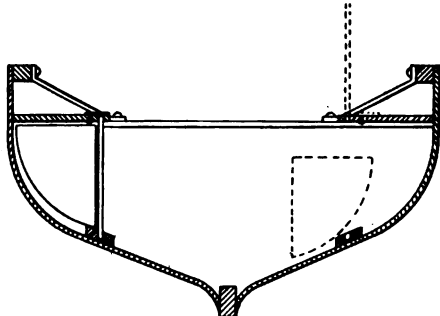
Claim 1.—In a hydro-aero machine, the combination of one or more air plane supporting surfaces extending transversely of the machine in lifting relation thereto, rigid floating means for supporting the machine on the water including a forward buoyant portion having a hydroplane surface commencing at a point well in advance of the center of gravity of the machine and extending downwardly and rearwardly, terminating in a rearwardly facing step in the vicinity of a vertical line through the center of gravity of the machine, and a rear buoyant portion extending well to the rear of the center of gravity of the machine and



constituting a tail portion decidedly lighter per unit of length and of a decidedly less displacement per unit of length when the machine is at rest on the water, than the forward buoyant portion, said rear portion having a bottom surface commencing at the rear of the step and higher than the bottom of said forward hydroplaning surface, whereby the machine may rock about the step and plane on the water at speed with its tail portion decidedly raised above its normal displacement to readily break from the water, the machine when at rest being supported on both bottom surfaces of said forward and rear buoyant portions to give longitudinal stability, and means for driving the machine at such speed as to cause it to rise from the water. Twenty-eight claims.

1,144,434. BOAT. AXEL A. SAWMAN, OF BROOKLYN, N. Y.

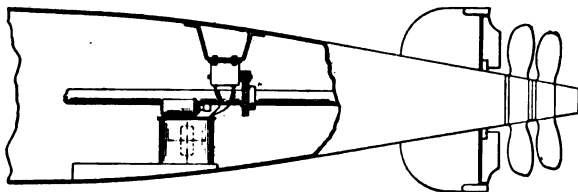
Claim.—The combination of a boat, side seats thereof, having a space beneath them, a series of tanks substantially filling said space, removable



rods adapted to prevent lateral removal of said tanks, and means to lock said rods. One claim.

1,145,025. GYROSCOPIC STEERING DEVICE. FRANK M. LEAVITT, OF SMITHTOWN, N. Y., ASSIGNOR TO E. W. BLISS COMPANY, OF BROOKLYN, N. Y., A CORPORATION OF WEST VIRGINIA.

Claim 1.—The combination with an automobile torpedo of a gyroscope for controlling its steering, a spinning-up mechanism adapted to



spin up the gyroscope to normal speed during the launching operation, and an electro-motor associated with the gyroscope and a generator therefor associated with and controlled by the torpedo driving mechanism, adapted after the torpedo motor has acquired normal speed to keep the gyroscope revolving at normal speed. Four claims.

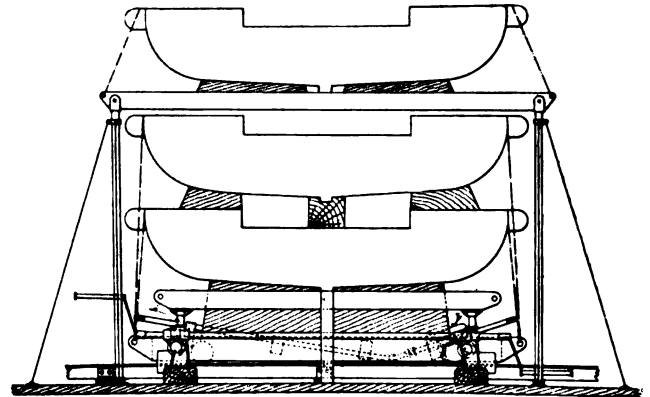
1,133,282.—TORPEDO. GUSTAV P. HELFRICH, OF NEW YORK, N. Y.

Claim 1.—In a torpedo a casing provided with a plurality of compartments, a spool arranged in one of said compartments, said spool being designed to carry a wire, means for supplying current to said wire, means arranged in said casing connected with the wire on said spool for propelling the torpedo, means for supplying a water jet, means for supplying an intermittent light, means for automatically controlling the tossing of the torpedo, and means for turning the torpedo to the right or left, according to the amount of current impressed on the wire on said spool. Nine claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

21,492/1914. MEANS FOR STOWING SHIPS' LIFEBOATS. THE MARTIN PATENT DAVIT COMPANY, LTD., 9, UNION COURT, LIVERPOOL, AND E. S. GLADSTONE.

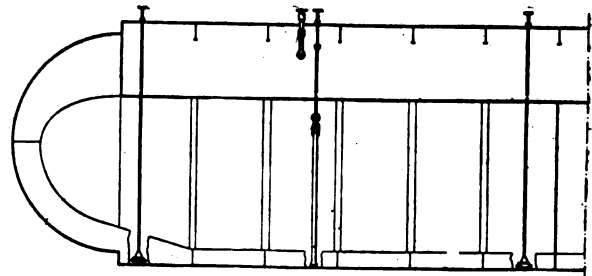
Where lifeboats are stowed in tiers of two, three or more boats one above the other it is in some cases considered desirable that the upper boat or boats should not rest directly on the boat or boats beneath, but should be separately supported. According to the invention the supports are so constructed that a complete tier of boats can be deposited on a carriage and moved away clear of the supports. An intermediate



boat is supported on the lowest boat and the top boat is carried by cross beams supported by uprights hinged to the deck and supported by guys. A platform is carried by lifting means and adapted to lower the tier of boats on to the carriage. When it is desired to move the boats in the side of the ship the platform is raised until the intermediate boat comes against the cross beams, the supports are then disconnected from the cross beams and turned down on their hinges so that the lowest boat supports the weight of the intermediate and top boats; the platform is then lowered until the lowest boat settles down on the carriage, which can then be moved away as desired.

14,762/1914. MARINE STORAGE TANKS FOR OIL. W. DOXFORD, PALLION SHIPYARD, SUNDERLAND, AND C. P. M. JACK, 82 GREAT ST. HELENS, LONDON.

Claim.—This invention relates to marine storage tanks for oil, of the kind so constructed that when loaded with oil they will either float, or be completely submerged lying on the bottom, or will float with one end on the bottom, or will lie on the bottom partly submerged. To this end there are pipe connections arranged in such a manner that the oil storage compartment is always full, either of water, or of oil, or of



oil and water together, in the case of a craft that is intended to be entirely submerged. Thus the external head is balanced or nearly so, and the loads on the structure are very small so that within practical limits a very much larger cylinder or tank can be built than would be otherwise permissible. The oil is withdrawn from the oil compartment by an oil-section pipe at the highest level therein (e. g., it might be buoyed therein), and when oil is pumped out through this pipe, water flows in automatically through another pipe whose mouth may be on the exterior of the oil compartment above the bottom, but whose inner mouth opens into the interior of the oil compartment at the bottom.

6,318/1914. IMPROVEMENTS IN OR RELATING TO SAFETY DEVICES FOR SUBMARINE OR SUBMERSIBLE BOATS. SWAN, HUNTER & WIGHAM RICHARDSON, LTD., AND E. L. PEACOCK, OF WALLSEND SHIPYARD, WALLSEND-ON-TYNE.

According to this invention one or more of all dividing rudders, or planes, for controlling the depth are provided with other means which are adapted to cause said depth controlling means to act in a direction to stop the submergence and if desired to bring the boat to the surface, when the depth controlling means cease to be controllable, or when the boat reaches a certain predetermined depth.

11,834/1914.. TORPEDO DIRECTORS. SIR W. G. ARMSTRONG, WHITWORTH & CO., LTD., AND W. H. WADDINGHAM, ELSWICK WORKS, NEWCASTLE-UPON-TYNE.

Claim.—According to this invention the instrument can be used for two or more tubes which are not parallel so that several tubes can be fired from the same control position without too much space being occupied by the employment of a separate director for each tube. To the director arm is connected a telescope or other sight so that it can be moved independently of the arm to follow the target and means are provided for automatically discharging the torpedo when the line of sight coincides with the line of the director arm. There are also provided means for correcting the angle setting of the torpedo gyroscope and also for the distance between the instrument and the torpedo tube.